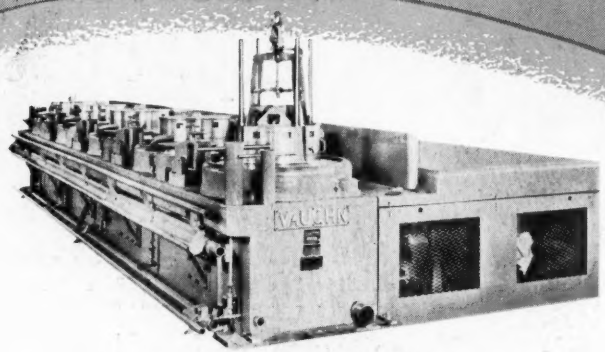
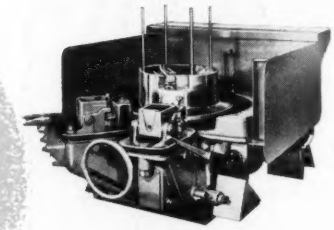
WIRE AND WIRE PRODUCTS

JULY 1946



TAKE IT *FAST* AND STEADY!



Consistent high-volume wire production is maintained by VAUGHN Motobloc and Motoblox on schedules as exacting as you please—because high operating speeds are balanced by heavy-duty construction refined for top performance through superior Vaughn engineering. Compare your current production problem with Vaughn's ability to solve it!

THE VAUGHN MACHINERY CO.
CUYAHOGA FALLS,
OHIO, U.S.A.

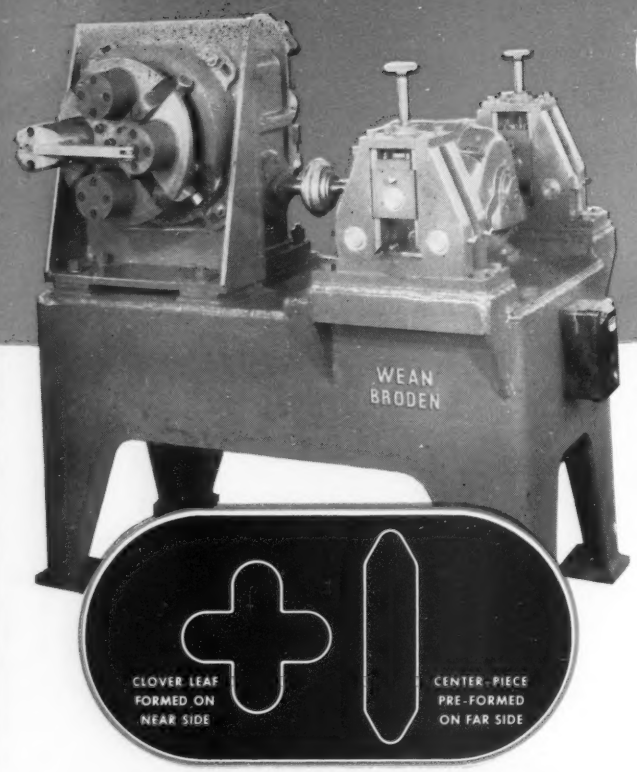
Vaughn

MOTOBLOC AND MOTOBLOX

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

WEAN • BRODEN

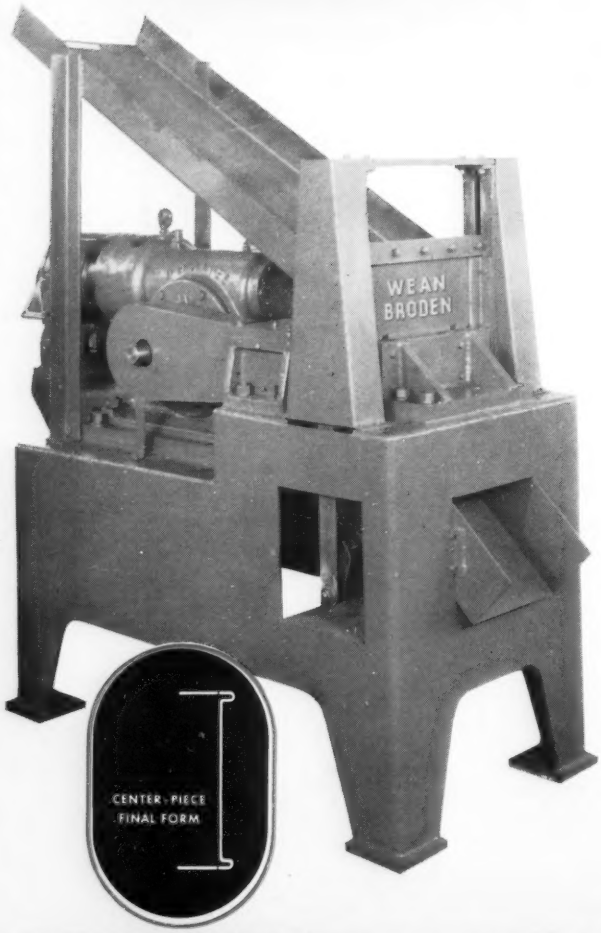


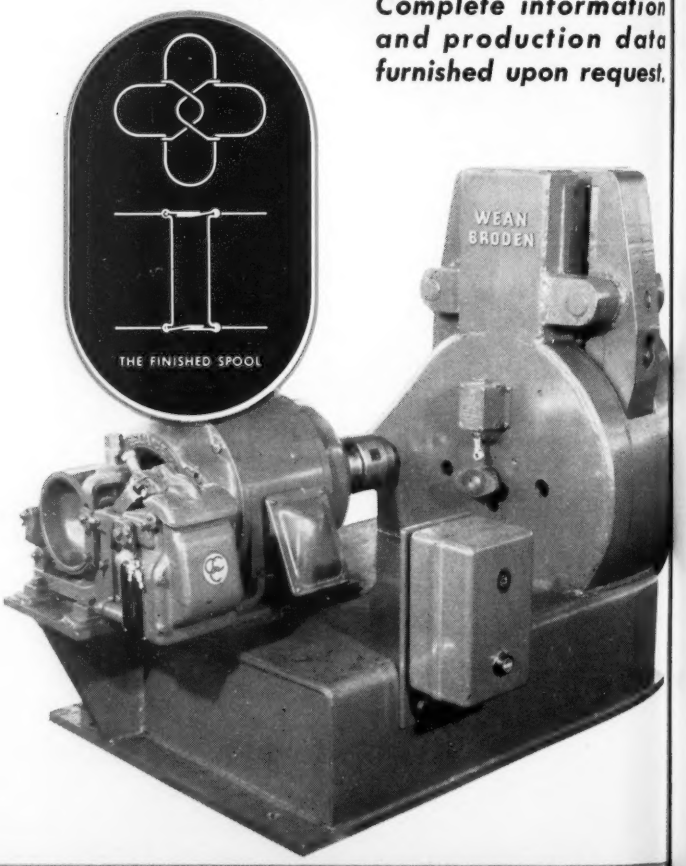
MACHINES FOR MAKING *Spools*

. . . Now for the FIRST TIME automatic machines are available for the making of standard spools that will fit any barbed wire machine.

These machines handle No. 6 gauge wire.

Complete information and production data furnished upon request.





The **BRODEN CONSTRUCTION CO** *Inc.* *Cleveland Ohio*

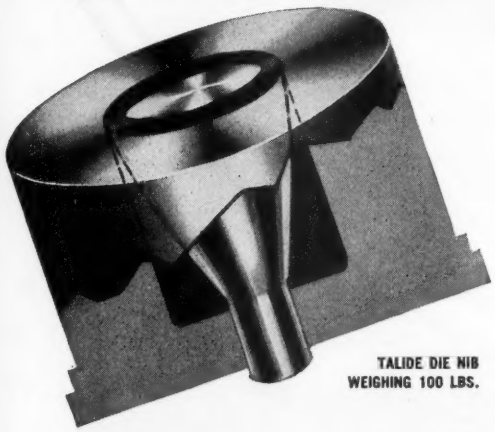
A Subsidiary Company of

The **WEAN ENGINEERING** *Company Inc.* *Warren Ohio*

Talide
(TUNGSTEN CARBIDE)

Performance!

OVER *3,000,000* Impressions from one TALIDE DIE



TALIDE DIE NIB WEIGHING 100 LBS.

Here's a cold forming job on alloy steel forgings 4¼" dia. x 15⅜" long which requires more pressure and generates greater friction than steel dies can take in one operation.

By replacing steel with a Talide Tungsten Carbide Die, the projectiles were swaged in one operation. Two operations were needed with steel dies. After three million impressions, the smooth, highly finished, large Talide Die needed no redressing. And in each of the three million, the operators reported complete elimination of galling, scratching and pick-up.

Talide Dies can be used for any cold working operation where steel dies wear out too fast or on applications too severe for steel dies. Metal Carbides make Talide Dies in all sizes up to 24" diameter, I. D.

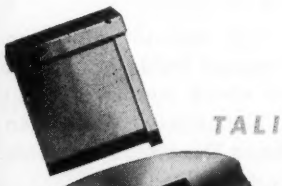
Complete information on TALIDE Tungsten Carbide Dies is given in Bulletin 43-WP . . . write for a copy.

TUBE MANDREL

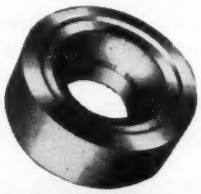
DRAWING DIES
(For Wire, Tubing and Bar Stock)

POWDER METALLURGY DIES
(For Compacting Powdered Metals and Materials)

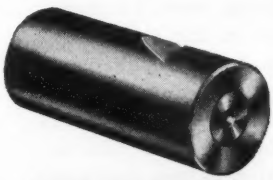
TALIDE METAL MEETS EVERY REQUIREMENT



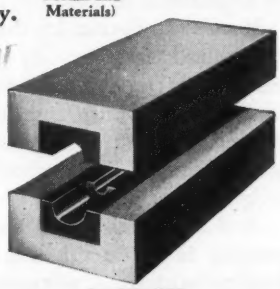
BLANKING AND FORMING DIE
(For Stamping Lamination Discs, Metals, Plastics, Paper)



SHEET METAL DIES
(For Deep Drawing Metal Products)



HEADING AND EXTRUSION DIES
(For Shaping and Sizing Bolts, Nuts, Screws, and Rivets)



SWAGING DIES
(For Forming Solid and Tubular Shapes)

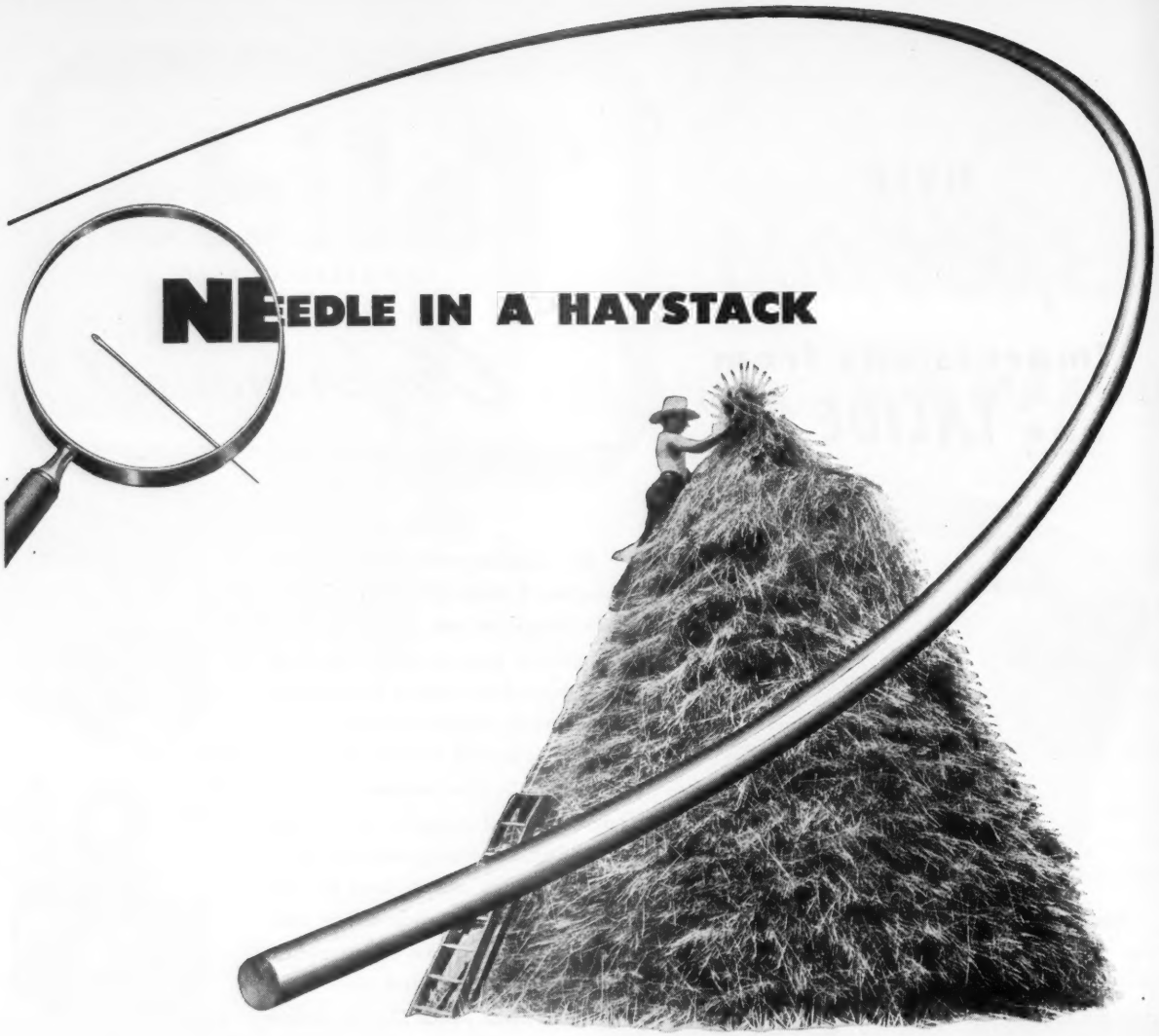
THE ENGINEERED CARBIDE FOR ALL APPLICATIONS

METAL CARBIDES CORPORATION

YOUNGSTOWN 5, OHIO *Pioneers in Tungsten Carbide Metallurgy*

SINTERED CARBIDES FOR CUTTING • HOT PRESSED CARBIDES FOR DRAWING AND WEAR RESISTANCE

NEEDLE IN A HAYSTACK



Looking for thin spots in a bethanized coating is about as hopeless as looking for a needle in a haystack.

Here's the reason for the perfect uniformity of the bethanized coating: By means of an advanced electrolytic process, a smooth, protective armor of 99.9 per cent pure zinc is built up, atom by atom, around the entire circumference of the steel base wire. Because it's applied atom by atom, by electrolysis, the coating can't be other than uniform.

And its ductility will amaze you! The bethanized coating is so ductile that bethanized wire can be bent or twisted . . . wrapped around its own diameter . . . even drawn to fine gauge . . . and the tightly applied coating of zinc won't be loosened in any way. Because of its uniformity, both around and along the wire, the bethanized coating fights off rust at every point. Yet for service where corrosive conditions are unusually severe, bethanized coatings can be supplied up to three times the weight of those specified in conventional Type 3 galvanizing.

Next time you have a difficult forming job, give the nod to bethanized. Additional information may be obtained from Bethlehem, Pa., or from the nearest Bethlehem Steel district office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation.
Export Distributor: Bethlehem Steel Export Corporation.

★ Bethanized Wire ★

BETHLEHEM STEEL

★

WIRE & WIRE PRODUCTS, Vol. 21, No. 6, July, 1946, Publication Office, 61 Cliff St., New York 7, N. Y. Executive Office, 300 Main St., Stamford, Conn. Published by the Quinn-Brown Publishing Corp., Richard E. Brown, President; R. S. Spengel, Sec. and Treas. Subscription price: U. S., $5.00; Canada, $5.00 per year, 50 cents per copy; Foreign, $7.50 per year. Entered as second class matter June 14, 1946, at the Post Office, New York, N. Y., under Act of March 3, 1879.

WIRE IS AVAILABLE

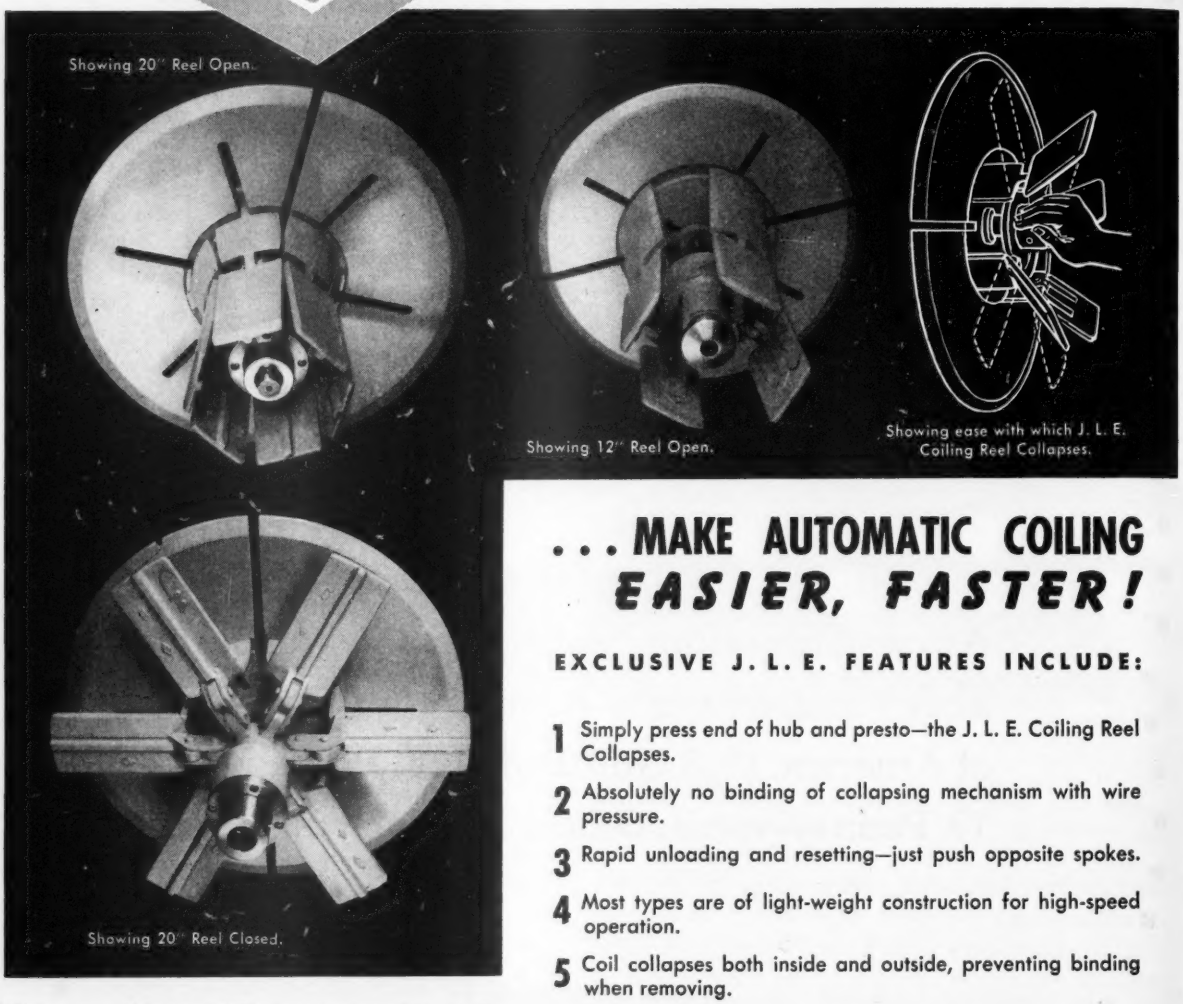
You can get it in Alcoa Aluminum

There *is* a bright spot in the supply picture. If you need wire you can get it in Alcoa Aluminum. Available in standard alloys and tempers. Aluminum Company of America, 1828 Gulf Building, Pittsburgh 19, Pennsylvania. Offices in principal cities.

ALCOA FIRST IN ALUMINUM

IN EVERY COMMERCIAL FORM

COLLAPSIBLE COILING REELS



There are thirteen different types of J. L. E. Collapsible Coiling Reels embracing the following range of outside diameter sizes: 12", 16", 20", 23", 26", 30", and 36".
Ask for complete specifications and prices on all types. Write today.

. . . MAKE AUTOMATIC COILING *EASIER, FASTER!*

EXCLUSIVE J. L. E. FEATURES INCLUDE:

1. Simply press end of hub and presto—the J. L. E. Coiling Reel Collapses.
2. Absolutely no binding of collapsing mechanism with wire pressure.
3. Rapid unloading and resetting—just push opposite spokes.
4. Most types are of light-weight construction for high-speed operation.
5. Coil collapses both inside and outside, preventing binding when removing.
6. Finished coil has a perfectly rectangular cross-section.
7. Provision is made for grounding end of wire when spark-testing.
8. Provision is also made for holding ties in place, if this is desired, before winding.

JAMES L. ENTWISTLE CO.
43 CHURCH STREET, PAWTUCKET, RHODE ISLAND
World's Leading Manufacturer of Spark-Testing Equipment
Chicago Office: Room 447, Monadnock Bldg., 53 West Jackson Blvd., Chicago, Illinois. British Associates: General Engineering Co., Ltd., Bury Road, Radcliffe, Lancs., England. Canadian Representative: The A. R. Williams Machinery Company, Limited, Toronto, Ontario.

Yesterday's impossibility today's accomplishment

That epitomizes the results obtained in many important mills where F. E. I.-engineered heating equipment is in operation. One such installation, comprising F. E. I. patented Direct-Fired Cover Furnaces, in a large Eastern mill, is shown below. Performance records, from this and other prominent plants, are yours for the asking and speak a language more eloquent than anything else we could say.

F. E. I. specializes in studying existing heating troubles and in submitting recommendations and estimates to meet many new and exacting production objectives in wire, rod, strip, sheet and other mills, steel as well as non-ferrous.

These services of the F. E. I. organization, backed by 30 years of successful experience, are yours for the asking, without cost or obligations. When our recommendations include specific types of equipment not made by ourselves, we are glad to tell you where it may be obtained.

F. E. I. EQUIPMENT

Direct-Fired Cover Furnaces for annealing, spheroidizing, Normalizing and Bright annealing of wire, rods, coiled strip, flat sheets and tin plate.

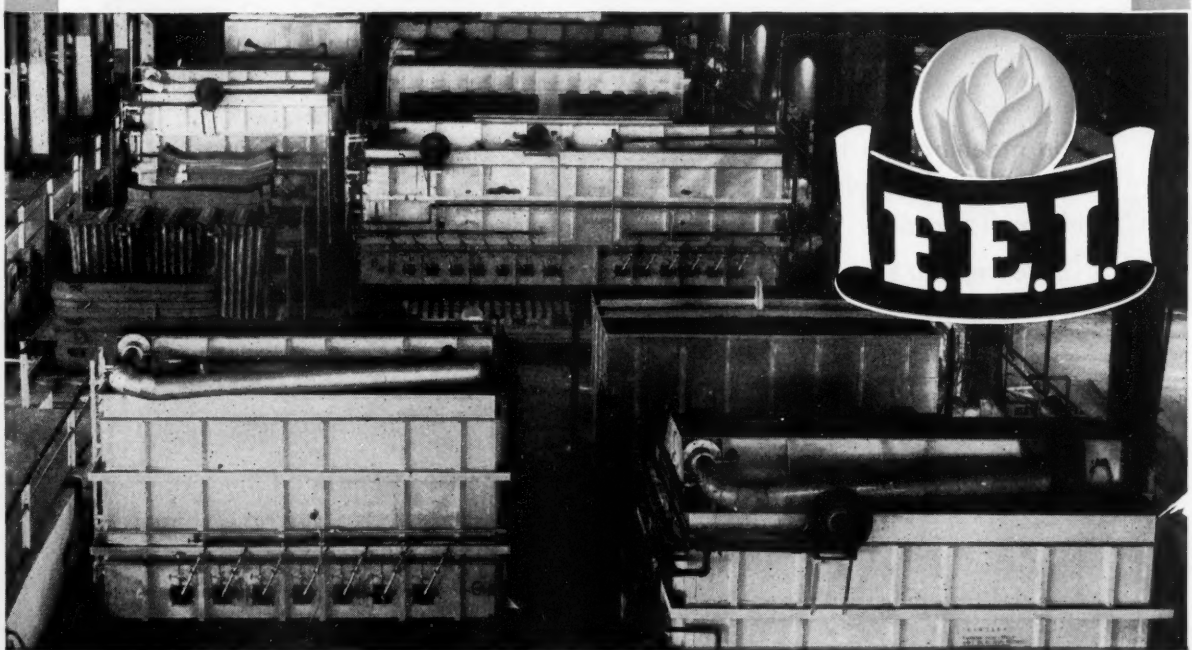
For heavy Coil Loads, patented Convection Base gives 200 to 400% longer service.

For Wire, Bar and Tube Mills: Galvanizing, Patenting and Normalizing Furnaces.

For Pipe, Sheet, and Job Plants: Hot Dip Galvanizing Furnaces.

Car Type Furnaces.

Ladle Heating Furnaces.

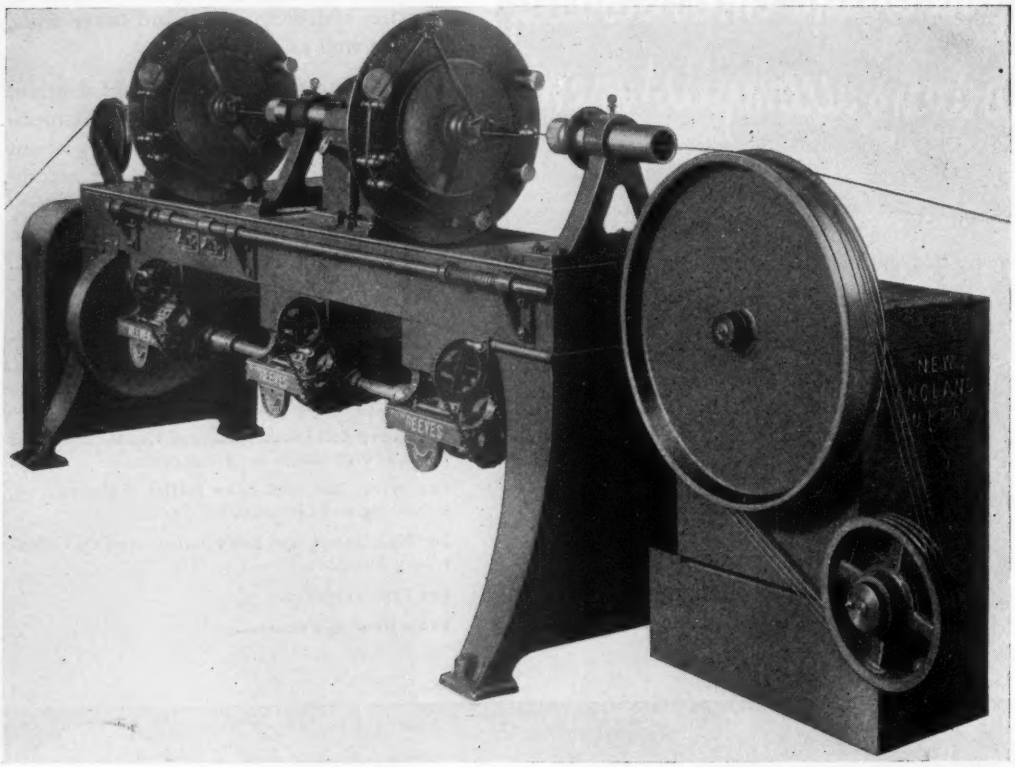


FURNACE ENGINEERS, Inc.

Specializing in the design, manufacture and installation of furnaces for the metal working industries

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

SMALL
HORIZONTAL TAPING MACHINE



The machine illustrated is a SMALL CONCENTRIC TYPE TAPING MACHINE for applying paper, rubber, synthetic, or varnished cambric tapes to small wires.

These machines, which may be built with one to four heads, as required, are of sturdy construction and feature as standard equipment:

Individually controlled variable speed on each head and capstan.

Automatic brakes and stop motions.

Grooved idler on capstan to prevent chafing of insulation.

Automatic tension control.

Special machines built to suit customer requirements.

Write for circular No. 81 for details.

NEW ENGLAND BUTT COMPANY

ESTABLISHED 1842
304 PEARL STREET
PROVIDENCE 7, RHODE ISLAND, U.S.A.
James Day (Machinery) Ltd., "Ford House," 88 Regent St., London., W.I., England

STANDARD WIRE DRAWING LUBRICANTS

INSURE GREASED LIGHTNING SPEED

Standard's wire drawing compounds are manufactured to facilitate greater speed in wire drawing and maintain the physical characteristics of all grades of steel, copper, or brass. They will produce the finish you require, — lime bright, extra bright, sull-coated, or special finishes for welding, lacquering, enameling, or plating.

A few of our Standard Lubricants are No. 91, No. 55, No. 108 and No. 40. Others have been listed in previous issues. They are for all types of processed wire, either high or low carbon, where hard finish is desired. Particularly adapted for tough operations. One of our technical men will demonstrate the merits of our products to prove our claims. Address

Standardize with Standard

STANDARD INDUSTRIAL COMPOUNDS COMPANY

4600 W. Ferdinand Street, Chicago 44, Ill.

Standardize with Standard

HUDSON WIRE COMPANY

PRODUCERS OF FINE WIRES IN ALL METALS

FINE BARE WIRES

High Brass, Low Brass, Zinc 99.99+ and High Tensile Zinc, Commercial Bronze, Phosphor Bronze, Pure Tin, Lead, Antimonial Lead, Tinsel Lahns, Silver Plated Copper, False Gold and Copper.

Cadmium, Nickel Silver (10%, 18%, 30%), Silver Plated Copper, False Gold and Special Brass and Bronze Alloys to Specification, Metallic Fibre for Packing Purposes, Copper, Bronze, Zinc, Lead and Aluminum.

WIRES FOR METAL SPRAYING

Pure Lead, Lead Alloys, Pure Zinc, Zinc Alloy, Copper, Tin, High Brass, Low Brass, Solder Wire, High Conductivity Electric Wire.

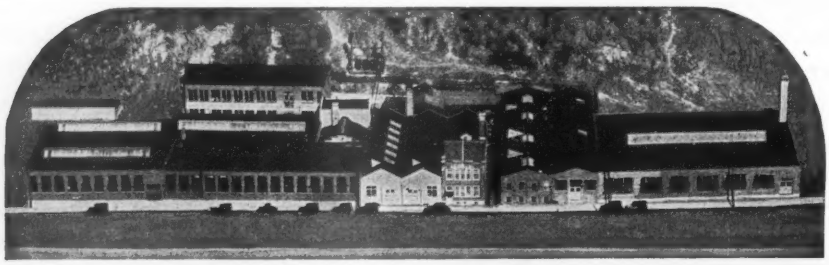
Cadmium, Nickel Silver (10%, 18% 30%), Aluminum, Monel Metal, Phosphor Bronze, Pure Nickel, Commercial Bronze.

Look for the name — **HUDCO** — A guarantee of quality

"HUDCO" specially processed Copper Wire for enamelling purposes is drawn from Selected Copper, insuring the maximum conductivity. This is but one example of the use of the most advanced and approved materials and methods in our processing.

BETTER WIRE AT LOWER COST

Write for Prices and Samples • Let Us Quote on Your Requirements

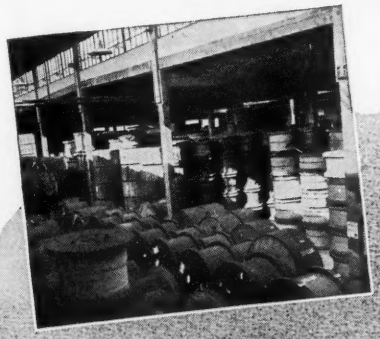


"HUDCO" PLANT AT OSSINING, NEW YORK

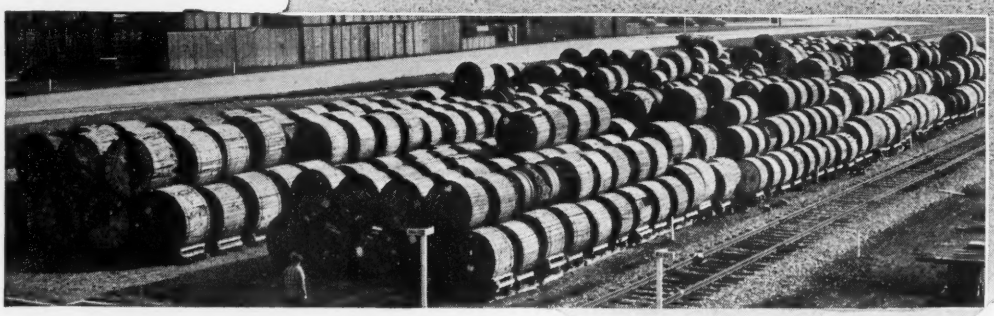
HUDSON WIRE COMPANY

Established in 1902 — Successors to Royle & Akin

OSSINING, NEW YORK



For Quick Sale . . .
ELECTRIC WIRE AND CABLE



The War Assets Administration has a large inventory of government surplus Wire and Cable. It was made by leading manufacturers for war purposes under close supervision to exact technical specifications.

Some of the types and sizes are standard and conform to underwriters' code. Others, while non-standard, are adaptable to a wide variety of uses.

Some suitable applications are circuits for:

power and light, radio, telephone and signalling,
ignition and control, plus battery charging,
instrument and switchboard wiring, welding, etc.

Priced far below its acquisition cost, it will appeal to construction contractors, oil well and mine operators, and ship builders. Ingenious engineers will find many ways to use this material to their advantage.

Get in touch with your nearest Regional Office of the War Assets Administration. Special technical personnel will be happy to give you data on specific types and sizes or arrange for your inspection of the material.

WAR ASSETS ADMINISTRATION

OFFICES LISTED BELOW ARE TEMPORARILY IN RECONSTRUCTION FINANCE CORPORATION AGENCIES

Offices located at: Atlanta • Birmingham • Boston • Charlotte • Chicago • Cleveland • Dallas • Denver Detroit • Helena • Houston • Jacksonville • Kansas City, Mo. • Little Rock • Los Angeles • Louisville Minneapolis • Nashville • New Orleans • New York • Oklahoma City • Omaha • Philadelphia Portland, Ore. • Richmond • St. Louis • Salt Lake City • San Antonio • San Francisco • Seattle • Spokane Cincinnati • Fort Worth (Telephone 3-5381)

319-2

VETERANS OF WORLD WAR II: To help you purchase surplus property, a veterans' unit has been established in each WAA office

Western Electric

. . . an outstanding user of Robertson Equipment

Keeping the nation's telephone bells ringing

It is no small task, even under normal conditions, to produce the telephone cable required by that industry for ordinary repairs and expansion. Today, when the demand for new telephones is greater than ever, it is an even bigger job to make the hundreds of miles of telephone cable needed. Western Electric has been, and is, meeting this demand capably and efficiently, as always.

Robertson is proud to have a hand in the work of opening new communication lines nation-wide. For Robertson lead cable-encasing presses help Western Electric in the manufacture of telephone cable.

Western Electric is *only one* of many leaders in the manufacture of lead encased cable that uses Robertson Equipment. It is this significant fact which stands out as the highest praise for quality and performance that any products could have.

JOHN Robertson
COMPANY INCORPORATED
125-135 WATER STREET, BROOKLYN 1, NEW YORK
Designers and Builders of all Types of Lead Encasing Machinery
Since 1858

9 WAYS to Improve WIRE DRAWING

FOR more than three years a new coating for wire drawing has been used by many mills instead of lime. The results obtained are outlined in the data submitted below.

MAGNUS METAL COAT #267

on the basis of the results it has obtained, warrants a most careful investigation on your part. Here is what it offers you:

1. **Better Finish** on any wire, particularly on stock drawn for metallic coating and other special finishes, and on bright, rope, welding and tire bead wires.
2. **Reduced Rejects**—rejects caused by scratching and off-size wire are virtually eliminated.
3. **Better Rust-Proofing** than was possible before Magnus #267 was introduced.
4. **Reduced Lubrication Costs** due to fact that #267 calls for lean lubrication. In many cases savings amount to as much as 50%.
5. **No Hydrogen Embrittlement** — which is eliminated right in the coating solution.
6. **Longer Die Life** on any drawing operation, but most striking on continuous, high speed operations.
7. **No Liming or Baking** eliminates the trouble, expense and mess of the liming operation and subsequent baking.
8. **Cleaner Machines and Surroundings** which result from the elimination of liming. Greatly improved working conditions.
9. **Reduced Overall Drawing Costs** as a result of savings in liming and baking costs and the improvements in product and operations. Ultimate cost per ton of wire drawn is much less than when lime is used in spite of the much higher initial cost of Metal Coat #267.

LOOK INTO #267

1921-1946 TWENTY-FIVE YEARS OF SERVICE TO INDUSTRY

MAGNUS

MAGNUS CHEMICAL CO., 188 SOUTH AVE., GARWOOD, N. J.

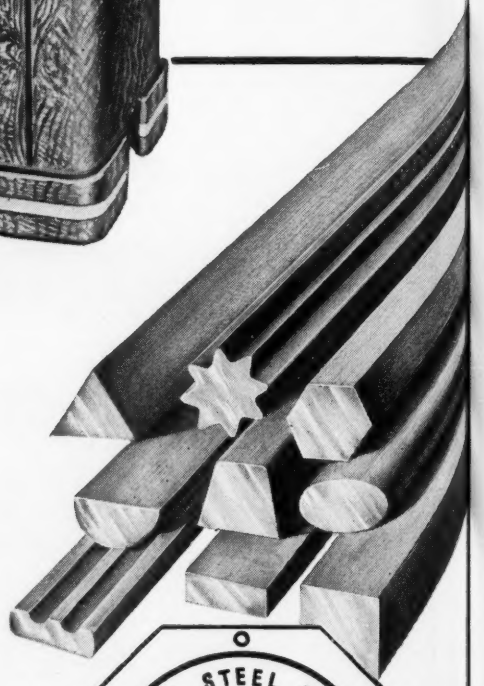
Wire Drawing Compounds

Easy ways

TO SALES APPEAL

• Here is how Continental wire made to a special shape is used by a manufacturer of gas heaters. Note how it adds beauty and utility to this gas radiating heater.

Continental wire is made in standard and special shapes in a great variety of sizes and finishes. There is a Continental wire to enhance the "sales appeal" of your product whether your needs are large or small. You are invited to write us about your requirements.



CONTINENTAL STEEL CORPORATION ★ SUPERIOR WIRE

CONTINENTAL STEEL CORPORATION

GENERAL OFFICES • KOKOMO, INDIANA

PRODUCERS OF *Manufacturer's Wire* in many sizes, shapes, tempers and finishes, including Galvanized, KOKOTE, Flame-Sealed, Coppered, Tinned, Annealed, Liquor Finished, Bright, Lead Coated, and special wire. ALSO, Coated and Uncoated Steel Sheets, Nails, Continental Chain Link Fence, and other products.

SYNCRO BUILDS

Quality machinery for *Quantity* production

YOU need QUALITY wire machinery to get QUANTITY wire production — year after year—with an absolute minimum of maintenance cost. Syncro builds only quality machinery for the wire industry—the kind of machinery capable of producing twenty-four hours a day for many trouble-free years. Weight where its needed, durability where it counts, special alloys where they add effective life, result in the balanced design, which combined with precision workmanship, has earned an enviable reputation for Syncro products in wire mills around the world.

Ferrous and non-ferrous wire drawing machines and a complete line of accessory equipment incorporating many novel time and money saving features, is available. We will welcome your inquiry for specific information.

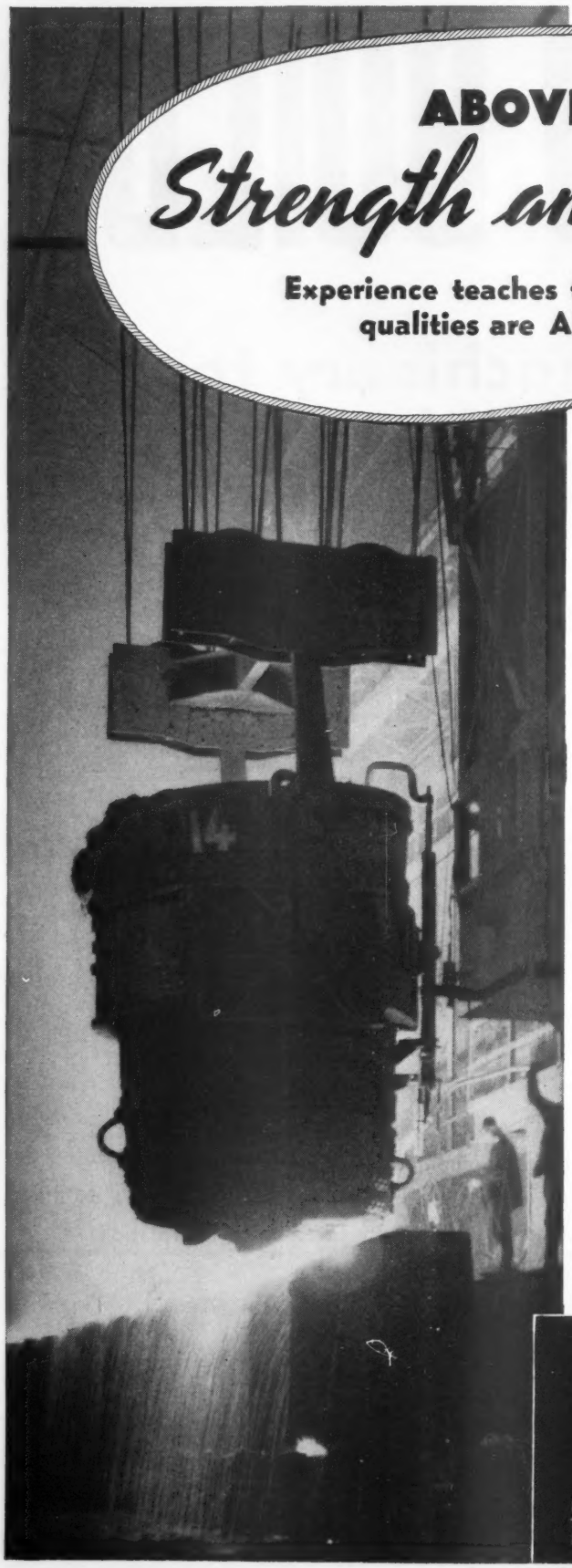
SYNCRO MACHINE COMPANY

REPRESENTED IN CANADA BY
CANADIAN ELEVATOR EQUIPMENT CO,
TORONTO

EXECUTIVE OFFICES AND GENERAL WORKS—611 SAYRE AVENUE, PERTH AMBOY, N. J.

Machinery for the Wire Industry

SYNCRO



ABOVE ALL!
Strength and Flexibility

Experience teaches that these Rope Wire qualities are ALWAYS "Firsts"

ONE of the toughest of all jobs that wire rope has is on the overhead crane that handles molten steel. Here the wire rope lifts a 170,000 lb. ladle, filled with 300,000 lbs. of steel. It must be spotted accurately for teeming into mold after mold. A break would mean loss of thousands of dollars in steel and mill equipment.

In short, the rope has to be good! It has to be strong and flexible--strong, to lift and carry its many-ton burden, day in, day out--flexible, to flow smoothly and efficiently over crane sheaves.

Strength and flexibility depend on the wire from which the rope is woven. These qualities, built into every foot of Yolectro High Carbon Rope Wire, are always "firsts," as are uniformity of gauge, toughness to resist abrasion, and ability to resist corrosion. Like all its wire mill products, the wire supplied by Youngstown to wire rope manufacturers is of finest quality steel, refined, rolled and drawn to exact specifications.

No user of wire rope has a better opportunity to test and prove the qualities of the product than the steel maker. Here, in the Youngstown open hearth department, steel for rope wire is being teemed from ladle into ingot molds

QUALITY TRADE MARK YOUNGSTOWN SERVICE

YOUNGSTOWN

THE YOUNGSTOWN SHEET AND TUBE COMPANY

GENERAL OFFICES - YOUNGSTOWN 1, OHIO

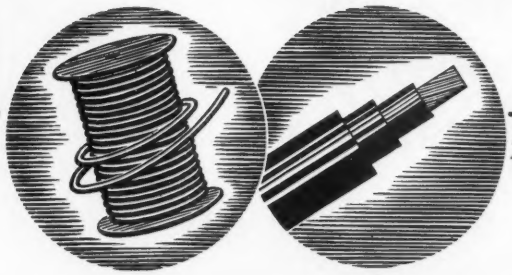
Export Offices - 500 Fifth Avenue, New York City

Manufacturers of

CARBON - ALLOY AND YOLOY STEELS

Electrolytic Tin Plate Coke Tin Plate Special Coated Manufacturing Ternes Tin Mill Black Plate Pipe and Tubular Products Sheets Plates Conduit Bars Rods Wire Cold Drawn Carbon Steel Rounds Tie Plates and Spikes.

SPECIALIZED RESEARCH EXPERIENCE



In All Types of Insulating Finishes and Impregnating Materials.

All Formulations made to individual specifications and to meet unusual requirements.

Our Hot-melt, Flame-resistant Compounds are non-toxic.

STANDARD VARNISH WORKS

Engineers of Product Finishes

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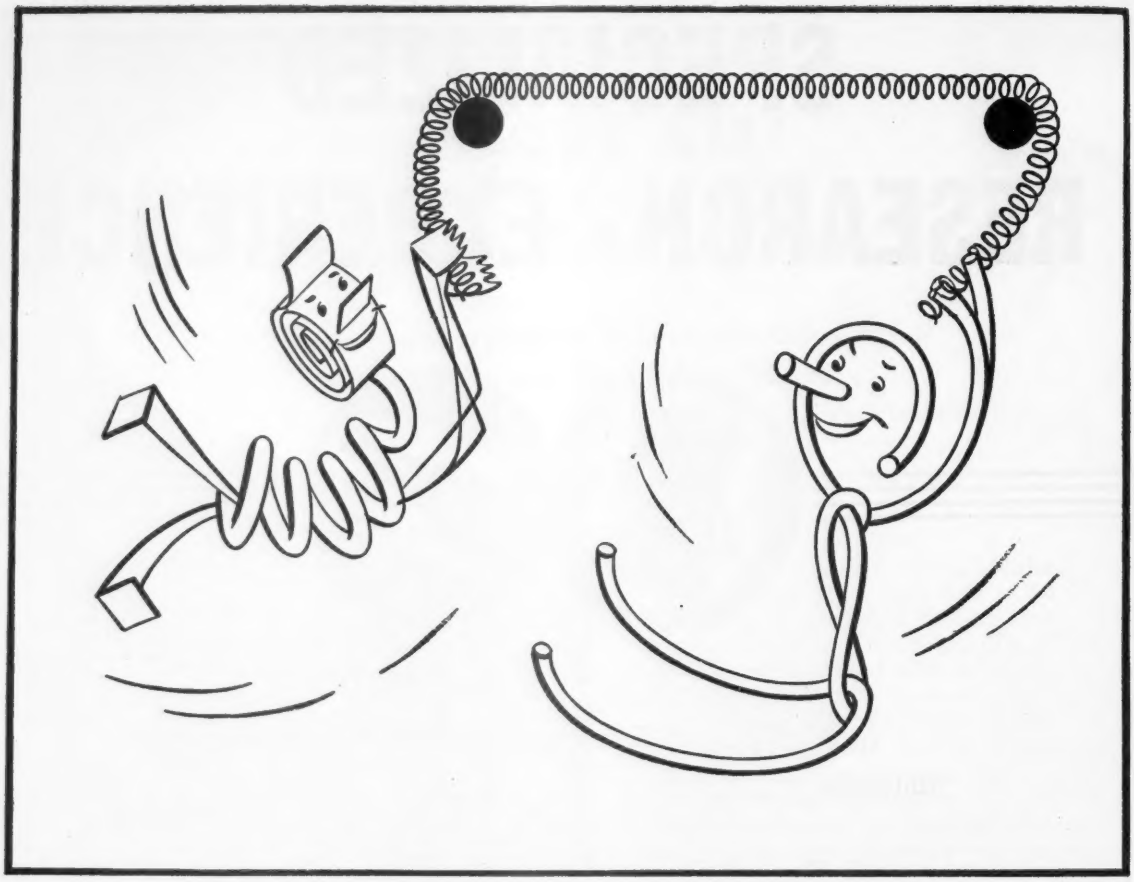

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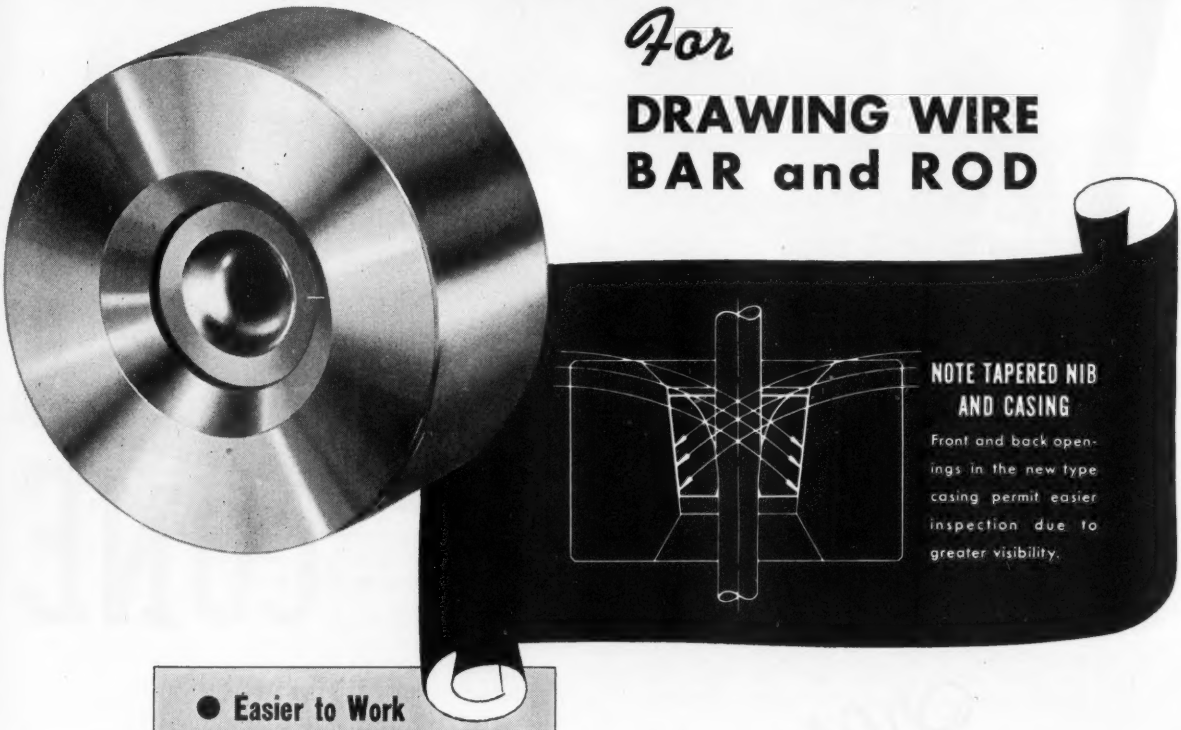
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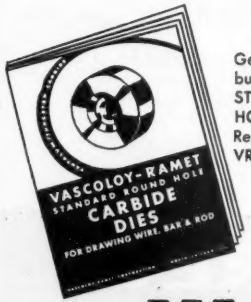

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The Wire Outlook

The spirit of American business is hard to quench. In spite of labor difficulties and government ineptness in laying a foundation for sound production, the total volume of business has remained high — mostly by virtue of heavy consumer spending. The Census Bureau reports that employment approximates war levels, 54,550,000 persons being on payrolls in April, up 1,600,000 over March. Electric power consumption has been just under 4,000,000,000 kw. weekly for many months, 10% lower than a year ago.

Steel was slowed down from a production of 89% in April to less than 50% in May, a situation that only more coal can correct, but the effects of the coal strike will be felt for a long period, with normal production not achieved until late in the year.

Rod and wire supplies for non-integrated mills is becoming increasingly serious. The CPA is planning certain export controls and domestic allocations to provide the non-integregated mills with more wire, primarily to increase the supply of nails for the veterans' housing program and other essential building. At present wire drawing operations are declining with further reductions immediately ahead.

Copper wire bars for June was expected to be the lowest for several years — about 18% of requirements. 50 to 60 thousand tons a month are needed with a supply of 10,000 tons available. Foreign purchases have not reached us yet and the Government surplus of copper, 100,000 tons of which is suitable for electric wire, has not yet cleared the red tape of bureaucracy. Result: greatly curtailed mill activity.

The lead shortage is held by the Lead Industries Association to be a purely artificial one created by Government controls. A free market is believed to be the answer. Meanwhile, a lead-hungry wire industry sweats and hopes.

Spring wire suffers from a shortage that even the price increase of April 1st cannot overcome in a hurry, since many big mills had turned from this unprofitable item to other commodities. Springs for automobile seats and seat backs and for beds are next to impossible to get for production schedules. Wire for valve springs and chassis coils, however, are in fairly good supply.

One industrialist recently expressed the view that so many concerns have duplicated orders that when wire gets into fairly good supply, much of this "water" will be cancelled out, and sooner than expected, possibly in six months, a competitive market will be upon us again and we'll be talking surplusses instead of shortages.

At present, copper magnet wire and lead have been placed on CPA's list of critically short items. Electric wire and cable companies are running anywhere from 25 to 75% of capacity, with many small mills shut down completely. This in effect is a paralysis that cannot long endure without far-reaching effects in many other industries.

While the President has again demonstrated his lack of courage in the face of a national crisis, it is to be hoped that those forces in Congress who so nearly overrode the Case bill veto will combine to frame a new bill that will cure labor leadership racketeering and domination. At least, they promise it. Their efforts will be supported by all who are at heart Americans. The difficulties from which we suffer are those which arise from the deliberate, calculated action of a very small group of selfish men who have placed their personal ambitions above the welfare of the country. They MUST be curbed!

— from the Editor's Desk

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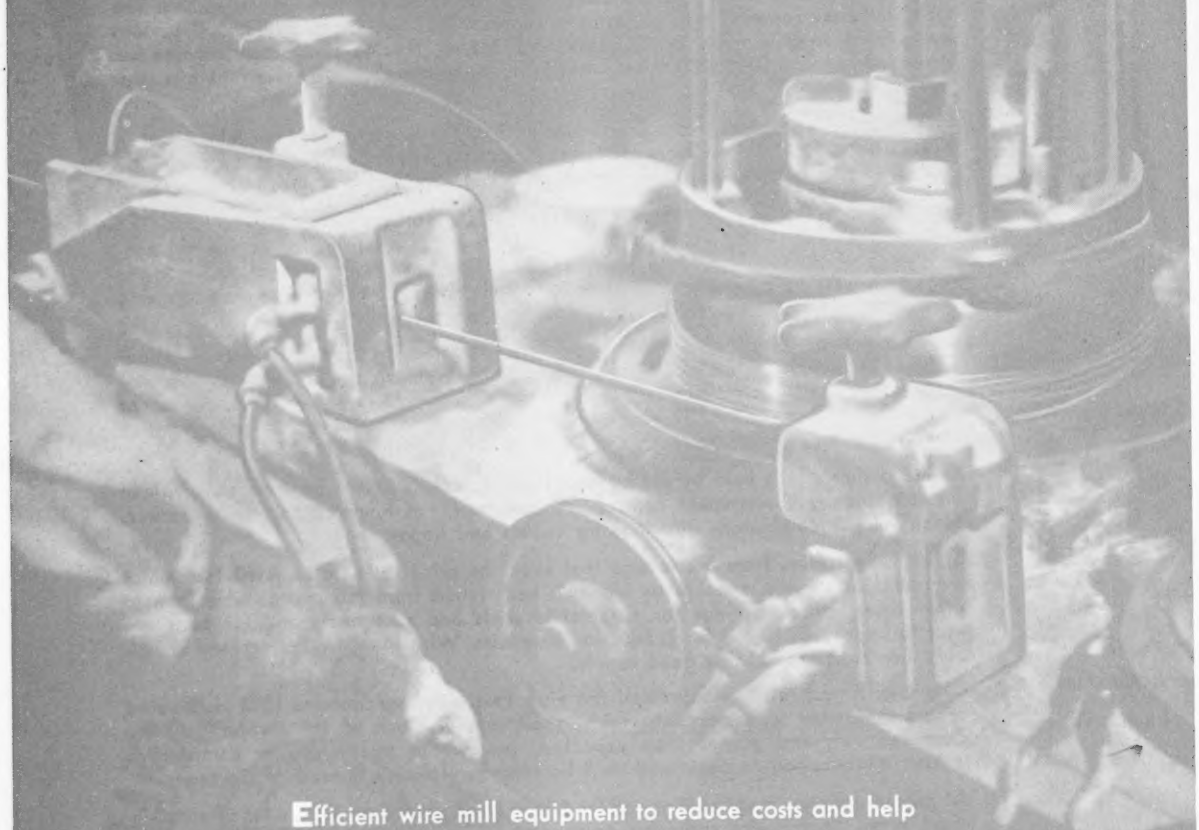

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DRAWING — ROLLING — EXTRUDING — FORMING — FABRICATING

Vol. 21 JULY, 1946 No. 7

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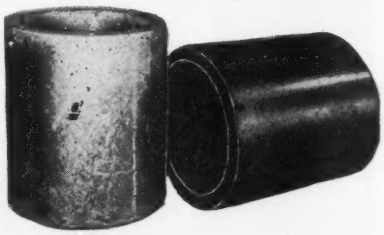

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DRAWING — ROLLING — EXTRUDING — FORMING — FABRICATING

Vol. 21 JULY, 1946 No. 7

Microhardness Testing of Fine Wire and Small Parts

By G. E. Shubrooks

Chief Chemist and Metallurgist
Hamilton Watch Company
Lancaster, Pennsylvania

Contribution from Research Engineering Division, Hamilton Watch Company, Lancaster, Pennsylvania.

THE Tukon hardness tester, utilizing the Knoop indenter, has proved to be an invaluable tool for testing fine wire, metal and nonmetallic parts which are too thin to be tested with the standard Rockwell or Rockwell Superficial hardness testers. At Hamilton thousands of small parts and samples of fine wire have been tested by this instrument during the past four years.

* * *

THE Tukon tester is manufactured by the Wilson Mechanical Instrument Company and their recent models incorporate an electrical device for reducing the impact between the specimen and the indenter. The Tukon tester at Hamilton, shown in Figure 1, was one of the first models in use and has been rebuilt to include this feature. Hardness readings may be recorded as Knoop numbers or may be converted to Rockwell hardness numbers.

* * *

EXTREMELY shallow hardness indentations are made possible with the Knoop indenter, first described by Knoop, Peters and Emerson (1). The indenter is a pyramidal diamond cut to the angles indicated in Figure 2. It is applied to a polished metal surface with a load of 25 to 3600 grams, depending on the relative hardness and thickness of the metal being tested. The load is automatically applied by push button control for twenty seconds, which has been determined to be the minimum time required to give consistent results. The resulting indentation, Figure 3, has an elongated diamond shape which permits extreme sensitivity of measurement. The long diagonal measures approximately seven times the width and thirty times the depth of the indentation.

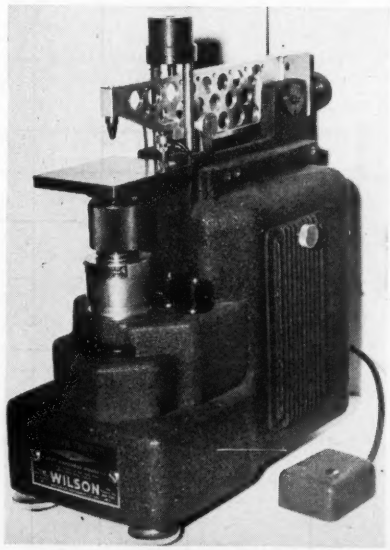


Fig. 1.—The Tukon tester, showing Knoop indenter at forward end of perforated beam and rising platform on which specimens are tested.

* * *

THE specimen to be hardness tested is usually mounted in a melamine thermosetting plastic and polished on fine emery papers and a fine abrasive lap. After polishing, the specimen surface should be flat and free of deep scratches. Hardness indentations are made with the Tukon tester on the polished surface and the long diagonal is measured with a filar micrometer microscope. The Knoop hardness number may then be determined by converting the micrometer reading to millimeters and referring to a table supplied by the Wilson Mechanical Instrument Company. The table is computed for a theoretically perfect indenter and cannot be used when extreme precision is required. When maximum accuracy is desirable the

following equation is used for calculating the Knoop number:

$$I = \frac{W}{A} = \frac{WF}{L^2K^2C}$$

where

I=Knoop hardness number
W=Load applied to indenter (in kilograms
A=Projected area of indentation (in square mm)
F=Correction factor supplied by National Bureau of Standards for each Knoop indenter
L=Length of indentation (in micrometer units)
K=Calibration factor for converting micrometer units to millimeters
C=0.07028, a constant for converting indentation length in millimeters to projected area

If we let Q replace F/K^2C (a calibration constant which can be calculated for every indenter and optical system) the equation may be simplified as follows:

$$I = \frac{W}{L^2} \cdot \frac{F}{K^2C} = \frac{QW}{L^2}$$

Taking the logarithm, the equation becomes

$$\log I = Q \log W - 2 \log L$$

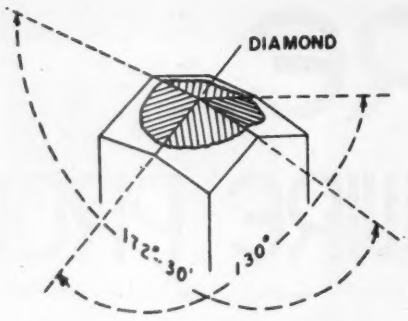
which is a family of straight lines when plotted on logarithmic graph paper. It is possible to plot the graph on a scale sufficiently large to prevent introducing errors greater than the probable error in measuring the identation. Figure 4 shows a typical graph plotted for loads of 0.5 and 1.0 kilogram. For loads other than these, the 1.0 kilogram line is used and the Knoop number obtained is multiplied by the actual load to get the true Knoop number. The advantages of such a graph are threefold. First, it is possible to determine rapidly the value of the Knoop number; second, the Knoop number obtained is of maximum accuracy; and third, the micrometer reading is used directly without conversion to millimeters.

* * *

THE escape wheel shown in Figure 5 at a magnification of 16X is typical of watch parts which are regularly Tukon tested. The outside diameter of this wheel is 0.171 in., approximately half the diameter of an ordinary lead pencil. Figure 6 shows an indentation made with a 0.3 kilogram load in an escape wheel tooth at a magnification of 250X.

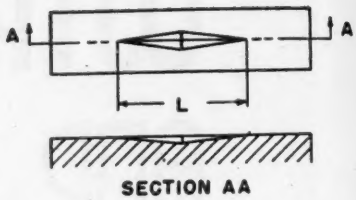
* * *

FINE flat wire may be tested without the necessity of mounting, by stretching the wire across a flat steel block. Figure 8 shows an indentation made with a 0.1 kilogram



INDENTER

Fig. 2.—Knoop indenter, showing angles between the edges of the flat pyramidal diamond point.



INDENTATION

Fig. 3.—Diagram of Knoop indentation. Ratio of length to width is 7:1; ratio of length to depth is 30:1.

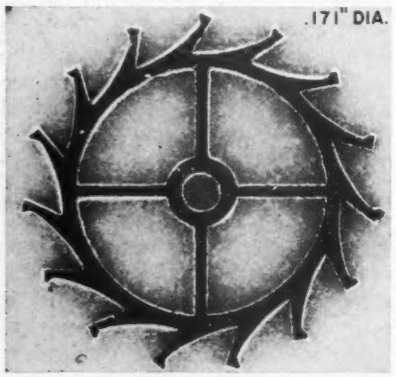


Fig. 5.—Watch escape wheel typical of watch parts regularly Tukon tested (X 16).

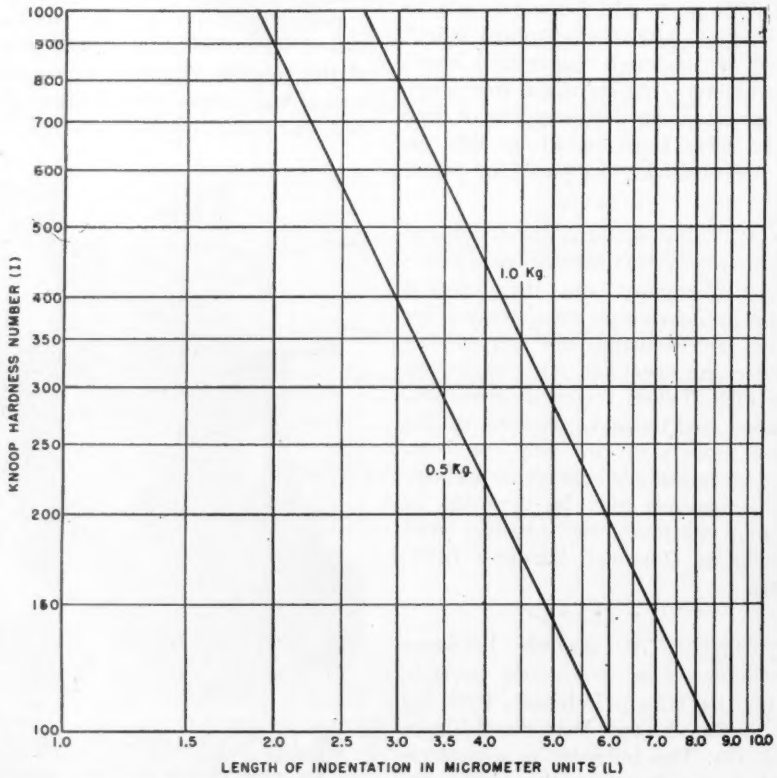


Fig. 4.—Graph for converting length of indentation to Knoop hardness numbers.

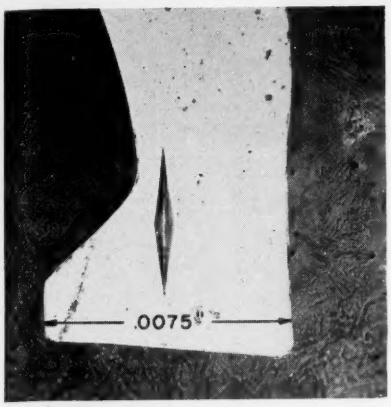


Fig. 6.—Knoop indentation in tooth of escape wheel shown in Fig 5 (X 250). Load of 0.3 kilogram.

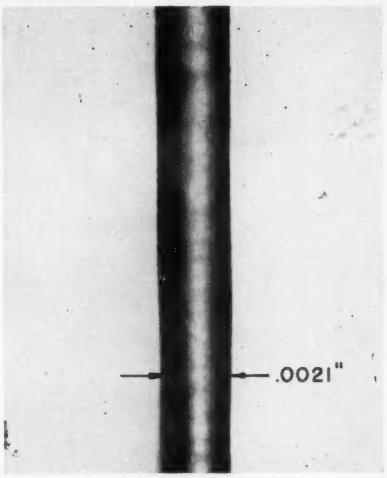


Fig. 7.—Human hair at same magnification as Figs. 6 and 8 to illustrate small size of parts tested (X 250).

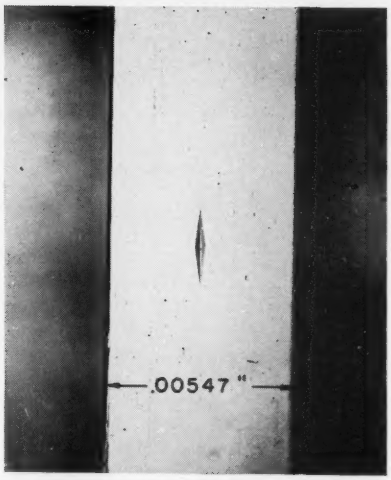


Fig. 8.—Knoop indentation in flat hairspring wire 0.00547" wide by 0.00107" thick (X 250). Load of 0.1 kilogram.

load in a piece of flat hairspring wire at a magnification of 250X. The dimensions of this wire are 0.00547 in. by 0.00107 in. It should be noted that the width of the wire (0.00547 in.) is shown in Figure 8. The small sizes of this wire and of the indentation are readily seen when compared to a human hair shown in Figure 7 at the same magnification (250X). Flat hairspring wire as fine as 0.00387 in. by 0.00074 in. is also accurately tested. The thickness of such wire is about 35 per cent that of human hair and the depth of an indentation is approximately 10 per cent of the thickness of the wire.

* * *

ON many occasions the metallurgist desires to make a study of the microstructure and hardness of small tools such as taps, dies, drills, and punches. In such cases the sample is prepared for microscopic examination by mounting in plastic, polishing and etching. After examining and photographing the sample it is Tukon tested without additional preparation. An example of this study of small tools is a threading die used for making watch screws (0.055 in. diam. thread; 100 threads per inch). This die is shown in Figure 9 at a magnification of 2X. In conjunction with certain machinability experiments it was necessary to know the microstructure and hardness of the die, particularly that of the threads. After completing machining tests with the die it was cross-sectioned, nickel plated, mounted in plastic, polished, etched, examined, photographed and Tukon tested. Figure 10 is a photomicrograph at 150X showing two threads of the die with two Tukon indentations which were made with a 0.3 kilogram load. The white layer on the thread is the nickel plating which was applied in order to prevent rounding at the edge of the sample during polishing. It should be remembered that the root of the thread on this die measures 0.01 in., and where such small dimensions are encountered it has been found that rounding in the polishing process causes erroneous results in Tukon testing.

* * *

THE Tukon tester is also useful in testing the hardness of nonmetallic materials, including minerals, glasses and plastics. Of especial interest in the watch industry is the testing of watch jewels made of synthetic sapphire (corundum). This extremely hard, brittle material may be Tukon tested in the same manner as metals. In Figure 11 a marine chronometer jewel is shown at a magnification of 19X. An in-

Fig. 9.—Small threading die used in making watch screws (X 2).

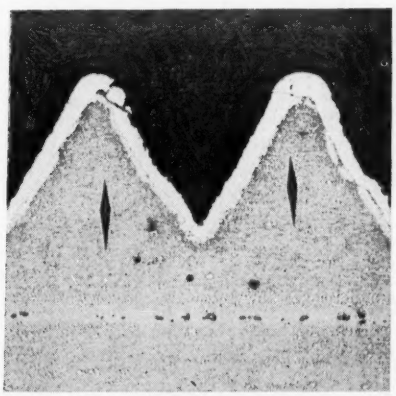


Fig. 10.—Knoop indentation in cross-sectioned threads of die in Fig. 9 (X 150). Load of 0.3 kilogram. White layer is nickel plate.

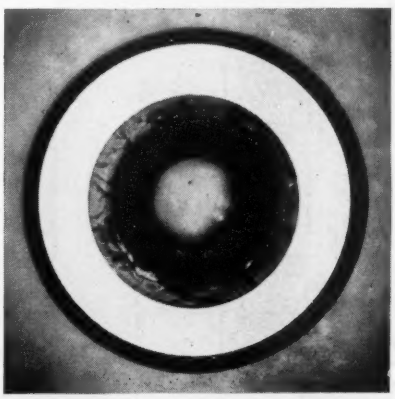


Fig. 11.—Marine chronometer jewel, made of synthetic sapphire showing highly reflective (white) polished surface (X 19).

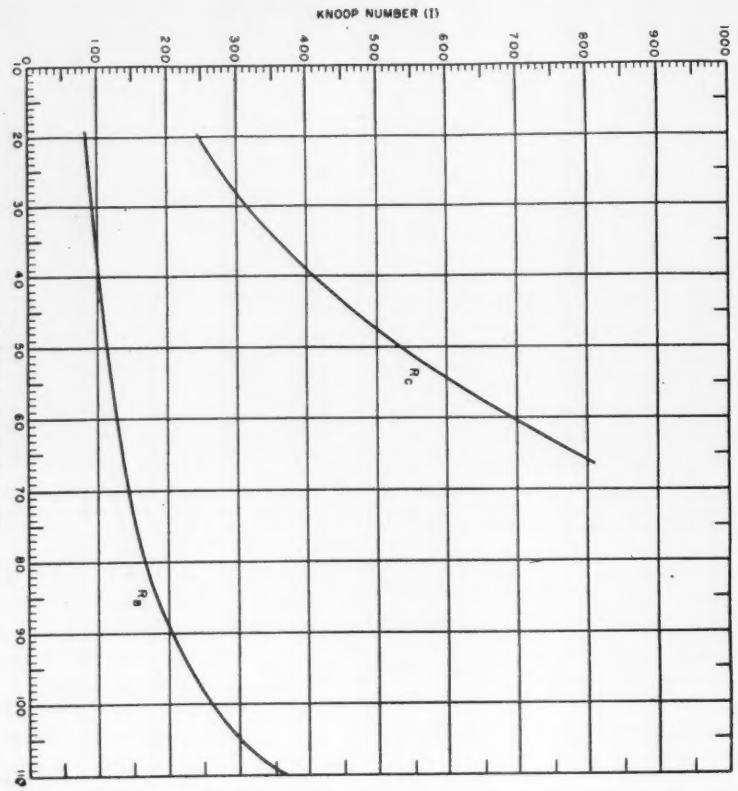


Fig. 13.—Chart for converting Knoop hardness numbers to Rockwell B and C numbers. Load of 0.3 kilogram.

dentation on the surface of the jewel made with a 0.3 kilogram load is shown in Figure 12 at a magnification of 800X. A sharp, clear indentation has been obtained without cracks or spalling.

* * *

IN specifying the hardness of metal watch parts the Rockwell B and C scales have been used in the past. For this reason it was desirable to prepare charts correlating the Rockwell numbers with the Knoop numbers. Figure 13 is a conversion graph which was plotted from data carefully accumulated by making numerous Tukon tests, with a 0.3 kilogram load, on Rockwell standard test blocks. This particular load was chosen for making the conversion chart because it is a load frequently used in testing small parts and fine wire. The chart will give approximate correlation values for loads other than 0.3 kilogram, with increasing deviation at lower loads. It is interesting to note the difference in the shape and slope of the Rockwell B and Rockwell C curves, which may be explained by the fact that a steel ball indenter is used for the B scale and a conical diamond indenter is used for the C scale.

* * *

IT has been indicated in the foregoing paragraphs that the Tukon tester is an extremely versatile instrument, capable of testing many materials, both metallic and non-metallic. Its range actually extends from the hardest materials, diamond, through the softest metals and minerals. Furthermore, the hardness of all these materials may be proportionally recorded on one scale, giving Knoop numbers of 8000 for diamond down to 32 for gypsum (Knoop, Peters, and Emerson). In Figure 14 the average Knoop hardness numbers of a few materials is shown graphically in order to

(*Turn to page* 548)

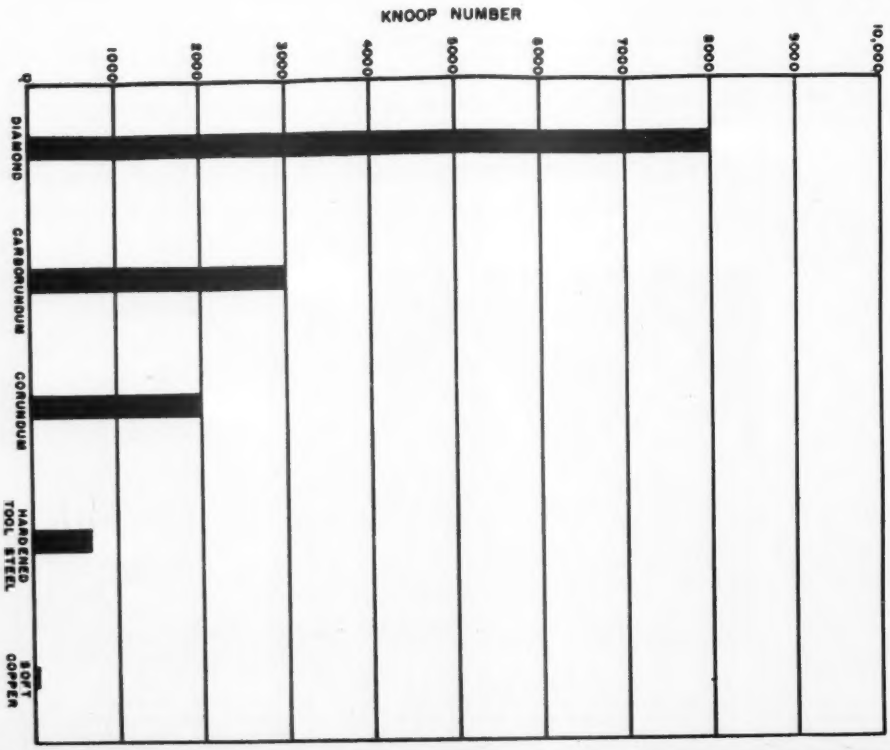


Fig. 14.—Knoop numbers of miscellaneous materials illustrating true hardness relationships afforded by Knoop hardness scale over wide range.

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A Review of Inhibitors

PART I—SECTION B

By Wallace G. Imhoff, B.A., B.S., M.S., Met. E.,
President the Wallace G. Imhoff Company
Los Angeles, California

Technical Director of Research
American Hot Dip Galvanizers Association, Inc.
Pittsburgh, Pennsylvania

FOREWORD

This review of Inhibitors was presented before the Wire Association Meeting in San Francisco, California, on June 7th, 1946.
The author's object in presenting this review is First to summarize all the work done by others on this subject and Second to attempt to explain clearly what he says takes place when Inhibitors are used in acid pickling baths.

THERE are enough inhibitor materials for everybody to have one, and have a theory about how it works. That is what makes it so confusing and so complicated. Even as late as 1943 John A. Henricks, in his very excellent paper, "An Interpretation of the Mechanism of Bright Electroplating", presented at the 82nd general meeting of the Electrochemical Society at Detroit, says, "The theory of the action of pickling inhibitors is somewhat controversial". There is the "Overvoltage Theory"; the "Film Theory"; the "Electrolytic Theory"; the "Reducing Theory"; the "Colloidal Theory"; and to this we might add the theories discussed in the field of "Electroplating", since some of the substances overlap and are found in both fields. In the Electroplating industry there is the "Adsorption Theory"; the "Reducing Theory"; the "Complex Ion Theory"; and the "Cathode Interference Theory". Other authorities offer additional explanations which have not been called theories, and it all is very complicated and bewildering to anyone seeking an explicit explanation of what really takes place. The best way to reveal what various authorities think takes place, is to give their theory.

* * *

THE following discussion is from the AMERICAN METAL MARKET, New York, December 13, 1929. The subject is — "HOW INHIBITORS ACT IN PICKLING SOLUTIONS". We quote as follows:

"The rate of solution of metals in acid solutions is reduced by certain inhibitors, said F. N. Speller, Metallurgical Engineer, National Tube Co., Pittsburgh, Pa., before the American Association for the Advancement of Science. This is due, he said, to an increase in the hydrogen over-potential, which is generally assumed to be due to formation of a film of discharged inhibitor substances absorbed on the cathodic areas. The theory of inhibitor action has been well stated as follows:

When immersed in acid, iron goes into solution at the anode areas, forming ions and discharging hydrogen ions at the cathode areas. These cathode areas may be said to occur principally in the narrow spaces of the grain boundaries in the steel, or between the metal and slag in wrought iron. Most inhibitors are either bases, such as quinoline, or positively charged colloids, and when these are present they travel to the cathode areas with the hydrogen. When the positively charged heavy particles are discharged, they cannot escape by gaseous evolution and accordingly are absorbed on the surface, building up a protective layer."

* * *

ALFRED DOUTY in his paper, "THE USE OF INHIBITORS IN THE PICKLING OF STEEL", presented at the Philadelphia Branch of the American Electroplaters' Society, states.

"Until recently the only inhibitors which had marked commercial success, have been the nitrogen-ring type. In 1926, however, Schmidt discovered the valuable sulphur-bearing class of which, in his patent, he disclosed the most powerful controlling agents yet produced; viz., the thioamides, particularly the thioureas. Commercial preparations based on this class of compounds bid fair to displace all other types for most applications."

AND in regard to theories on their action he says:

"Since 1922, several excellent papers have been published on restrainers and their action. No generally satisfactory theory has been evolved, however, which accounts completely for their properties. Sieverts and Lueg in 1922 made a rather unsuccessful attempt to correlate overvoltage and inhibiting power for quinolines. Ishgarishev and Bergman found that colloids like gum arabic and gelatin apparently increased the overvoltage of iron in dilute sulphuric acid, but could not find a quantitive relationship between the phenomena. They felt that inhibiting power was due to the formation of an inert film over the metal but had no definite evidence to support this view. Speller and Chappel investigated several inhibitors of the nitrogen-ring class and postulated some sort of film over the bare cathodic steel. Chappel, Roethli and McCarthy made measurements on quinoline ethiodide in dilute acid under a diversity of conditions. Their measuremnts of anodic and cathodic overvoltage showed that the effect was almost entirely confined to the cathode at which there was a large apparent increase in overvoltage. They ascribed inhibiting power to a layer of discharged inhibitor substance absorbed on the cathodic areas."

* * *

"Rhodes and Kuhn criticized the measurements of the last named authors on the ground that they had measured not the true overvoltage or increase in discharge potential of hydrogen ions, but a combination of this with the increase of potential due to increase of resistance at the interface. Rhodes and Kuhn's measurements show that compounds with quinoline nucleus increase the film resistance appreciably. They were also able to show that phenylacridine is absorbed by iron filings. However, they were unable to show any quantitive relationship between increase in film resistance and inhibiting power."

* * *

MR. Douty has brought out many very valuable facts and has left some questions unanswered, so for that reason it is important to further submit material which he has presented. He states further:

Published in Four Issues
Part I — Section A — Review. June 1946
Part I — Section B — Review, July 1946
Part II — U. S. Inhibitor Patents. Aug. 1946
Part III — Bibliography, September 1946.

"Evidence which has accumulated in our laboratory, coupled with the results of these investigators, seems to show that a combination of properties may be responsible for the effect, and that neither alone need be responsible in a given case."

* * *

"Arsenic, a powerful inhibitor, almost certainly acts because of its well known high overvoltage toward hydrogen. In conjunction with an organic controlling agent of almost any class its inhibiting power may actually stop attack by acid on iron."

* * *

"When a strong organic inhibitor is present in a dilute acid solution in which we immerse for instance a nail ,a peculiar effect is noticed. After some weeks, the nail seems to have undergone no change; no hydrogen evolution has been visible (its rate of evolution at any rate has been so slow as to have gone unnoticed). The nail has its original bright, shiny, metallic appearance, but when the tube is shaken, it is seen that it has lost much weight and has no metallic ring. On examination it proves to have been reduced to a hollow shell perhaps only a few thousands of an inch thickness. There still remains a thin film of iron, obviously protected from attack by an absorbed surface film. The nature of this phenomenon is far from easily understood. This result may also be obtained with a piece of strip steel initially covered with scale."

* * *

"Some substances possessing a high restraining power will not produce this effect. Among these is arsenic."

* * *

"While obviously not sufficient in themselves to lend much support to a general theory, yet these facts are suggestive, taken together with the published results of other investigators, of the possibility of two entirely different classes of phenomena giving rise to what may superficially appear to be indentical results—a retardation of the rate of solution of the metal."

* * *

"There still remain to be reconciled two stated facts and one which has been tacitly assumed in this paper:

1. Sulphuric acid baths (for example) attack the steel and not the scale.

2. Inhibitors retard the attack on the metal.

3. Pickling, i.e., the removal of the scale, is not retarded by the inhibitor.

* * *

How, we may well ask, is this paradox explained?"

Explanation of Paradox

THE theory as to the action of inhibitors seems to be very clear to the writer, but it is involved, so complex, and involves so many things that can be disputed, that the best way to present these new ideas seemed to be to state fully the theory of others, and by discussing them try to bring out these new ideas clearly.

WE will try to explain the first statement — "sulphuric acid baths attack the steel and not the scale". We will try to explain this fact on the basis of ionization and the electrolytic theory. On that basis the straight chemical reaction that takes place between iron and sulphuric acid is clear and well known to everyone. The formation of ferrous sulphate, the loss of the positive charges of the hydrogen, and the formation of the gaseous molecule of hydrogen gas are the simple results. The difficult question would therefore seem to shift to the answering of why the acid does not attack the scale. This explanation involves a new theory of the writer's as to what metallic skins and scales are composed of, and this seems to explain why the scale is not attacked by sulphuric acid, while the iron, or base metal is.

* * *

PROOF of the writer's theory on metallic skins is most easily verified by examining a slab of zinc with high cadmium content. Pure zinc is blue, and velvety in appearance and touch; the high cadmium zinc slab is silver-white in color, and very glossy. In other words by studying what has taken place here, we find the key to what takes place in scale formation on steel. In the case of the slab zinc the low melting, thin cadmium in the zinc has been chilled out first by the cold mold and thus forms the metallic skin over the zinc. Some years ago when the writer was a steel melter, it was observed, that skins, and the scales on steels were iron silicates mixed in with iron oxides, and on heats of steel that were badly oxidized, this blue, shiny, silicate iron oxide scale was absent. It is a well-known fact that sulphuric acid will not attack, or act on silica, so that it can at once be seen, that the acid attack on the scale becomes a function of the amount of the blue ferric silicate is present in the scale. Thus a "red short", or oxidized steel would be one either short of silicon, or where the silicon added has been entirely oxidized and carried off in the slag. As the silicon becomes an excess, it combines with the blue ferric oxide to form iron silicate, and this material is not attacked by sulphuric acid, because that acid has no action on silicates. There is another extremely important fact present, and that is since the iron is in the form of a silicate it is not ionized, and this explains WHY there is action on the iron base which is ionized, and not on the scale which is not ionized. Since scale is a mixture of the black oxide of iron, FeO, the magnetic oxide of iron, and the blue ferric oxide of iron, how fast the scale will be attacked will depend upon how much of the oxides are in chemical combination, or tied-to the silica. When the silica present is low the scales will dissolve easily; when the silica is present in large amounts the scale will be insoluble, and when there is no ionization, there is no chemical action on the scale. This theory of the writer seems to clearly answer the first question.

* * *

BEFORE answering the second question, we will now attempt to explain the action of the acid solution on the nail. This same theory seems to explains what happens there. The iron which is inside is readily ionized, and dissolves. The nascent hydrogen is taken up by the inhibitor, and the outside, undissolved shell would appear to be an insoluble film or skin that does not respond to the attack of sulphuric acid.

* * *

THE second statement is "Inhibitors retard attack on metal". In order to answer this question the writer must "jump the gun" on his theories and explanation for the action and behavior, and mechanism of the operation of inhibitors. Everyone with a theory seems to agree to the fact that a film is deposited over the cathode area. The difference of opinion and the difference of theory, and the confusion the writer believes is caused in trying to interpret the inhibitor action first with the lack of any film, next with a film of metal, and third with a film of colloidal material. It would appear that all the theories perhaps are right, but each sponsor has drawn his conclusions from the results obtained from the type and

kind of inhibitor he used, or is trying to explain. So once again an attempt will be made to clear up the confusion by answering statement number two.

* * *

WE can assume a type of inhibitor is used that does not deposit ANY FILM but merely takes up the nascent hydrogen as fast as it is formed by the action of the acid on the iron. By taking up the nascent hydrogen the action on the iron is stopped while it can continue reacting with the iron oxides in the scales on the steel. The oxides tied up as silicates, or as iron oxide-iron silicate are not attacked by the acid, and simply drop off as the other oxides are dissolved. Then we have the inhibitors that deposit metallic films over the cathode area. These inhibitors are inorganic salts such as tin chloride, copper salts, and antimony salts. As the deposit of metal over the cathode area smothers the surface, the action with the base metal iron is slowly "choked off" because the iron is no longer available when it is covered with the depositing metal over the cathode. Thus when it is completely covered by the depositing metal the action ceases.

* * *

THERE are also organic inhibitors which deposit a colloidal film instead of a metal over the cathode area. The writer has conducted many laboratory tests and watched these colloidal films slowly cover the cathode. When these films completely cover the cathode area then the action on the iron stops. This I believe perhaps is a new idea, namely that the covering film can be a metallic film, or a colloidal film depending upon the kind of inhibitor used. This explanation seems to clearly answer statement number two.

* * *

STATEMENT number three is, "Pickling, i.e., the removal of the scale, is not retarded by the inhibitor". To clearly understand why this can happen, we must again refer to the electrolytic theory. If an inhibitor stops, or retards the action of the acid on the iron, by stopping the formation of hydrogen, then it is apparent and clear that the acid attack on the scale to go forward because no film, or retarding condition is placed on the scale by the action, as it is on the cathode areas. The soluble iron oxides dissolve leaving the insoluble iron silicate scale to drop off the surface. The amount of action depends upon the amount of soluble iron oxides in relation to the amount of insoluble iron silicates that make up the scale.

* * *

PERHAPS the ideas just submitted may be brought out more clearly by submitting additional theories and discussions offered by other investigators on the subject. Under the title of "Modern Pickling — Results Achieved with Acids and Inhibitors Reviewed", O. L. Thomas states:

"Only within the last five or six years have efficient inhibitors been developed. These are organic compounds and usually have a nitrogen base. They are colloidally dispersed compounds carrying electric charges which form some sort of film over the bare cathode metal and prevent attack of the acid on the metal but do not affect the attack on the scale."

* * *

ANOTHER theory of inhibitors is given in The Iron Age, May 29, 1941, p. 37, "STILL TANK PICKLING" by James P. ApRoberts, Engineering Department, Lockheed Aircraft Corp., Burbank, Calif. He states:

"The mechanism of an inhibitor is that the inhibitor, being a finely dispersed colloid, will surround and adhere to the metal. The pickling acid will react on the scale and form ferrous or ferric salt which dissolves in the bath. Its action on the base metal, which ordinarily liberates hydrogen, will not occur to as great an extent, since the inhibitor prevents the hydrogen formation or further oxidation. Zappfe and Faust showed that inhibitors are effective in protecting the base metal from acid attack, that they also keep hydrogen from diffusing into the base metal and becoming occluded therein, and that they have a definite effect upon preventing hydrogen embrittlement."

* * *

THE writer specifically called attention to the reducing conditions of pickling baths, and his theories offered are based on this reducing action of hydrogen upon the various types and kinds of inhibitor materials and substances. A. D. Turnbull (Iron Age, Sept. 5, 1929, p. 598) agrees with this theory. He states:

"What takes place in the pickling bath when an inhibitor is present? In the case of inhibitors the hydrogen acts as a reducing agent by actually entering into the molecule. Carbohydrates like dextrose and glucose are highly reducing."

* * *

IN the electrolytic theory it is assumed that the iron oxide is negative while the base metal is positive, and that a cell exists. Also that the cathode, or negative pole may be iron carbide and that again a cell is formed with the positive base metal. The inhibitor is considered an insulator as will be noted by the following discussion:

"An inhibitor is no more that an insulating substance dissolved within the acid bath, which has a high positive charge waiting to be attracted by the negative cathodes or carbides. As the electrolysis gets in motion between the iron and the iron carbide, the inhibitor particle travels in the direction of the current and attaches itself to the iron carbide, thereby forming a thin insulating film over all the cementite areas, preventing any further flow of current."

* * *

Another theory states:

"The theory of the action of an inhibitor is that as the hydrogen bubble starts to form on the surface of the steel down in the bath, a higher surface tension in the liquid holds that bubble to the surface and, therefore, no more active acid can come in contact with that spot on the surface."

* * *

STILL another theory which attempts to explain the elimination of hydrogen gas states:

"We introduce into the pickling solution an organic compound composed of hydrocarbons, which prevents 'ionization' of the sulphuric acid which forms colloids, which tend to absorb the ferric oxide, thus producing the two sulphates and water."

* * *

ANOTHER article in BLACK AND WHITE, an E. F. Houghton & Co., publication, p. 26, November (no year on it, but believed to be about 1930), states:

"Inhibitors are divided into four classes —namely, 1. Salt Compounds; 2. Foaming Compounds; 3. Inhibitors; and 4. Catalyzers. It is stated, 'An inhibitor, although sometimes classed as a catalyzer, acts in an entirely different manner. It changes the physical consistency of the liquid and thereby acts as a retarder to certain operations of the process. For instance, introduction of an inhibitor to a pickle bath raises the surface tension of the liquid. This aids the selective pickling of steel versus scale but does not accomplish the same results as a catalyzer. Due to the higher surface tension a foam is usually noticed on top of the bath."

BURNS and Schuh state (p.61, PROTECTIVE COATINGS FOR METALS), in regard to the action of inhibitors:

"It may be observed that these organic inhibitors are positively charged colloids or organic compounds that ionize readily. Those substances become absorbed on the cathodic areas of the iron as the scale is removed and restrain the discharge of hydrogen. The resulting retardation of the acid attack upon the iron has been discussed and attributed to cathodic polarization. There is evidence that the inhibitive efficiency of certain organic compounds depend upon the structure and stereochemical arrangement of their positive ions."

* * *

C. B. FRANCIS states (pp. 1188 and 1189, THE MAKING, SHAPING, AND TREATING OF STEEL, 5th EDITION):

"An inhibitor is a substance which, added to the pickling bath, slows down or prevents the action of the acid upon the base metal but permits the reactions that result in the removal of the oxide or scale to continue. Substances of both organic and inorganic origin can inhibit the action of sulphuric acid upon iron. Inorganic inhibitors other than ferrous sulfate include arsenious and antimonious compounds and compounds of tin and mercury. The known organic inhibitors number at least 150 and range from such substances as red dog flour, cabbage leaves, gelatin, and glue to the highly complex synthetic organic chemicals of both the alipathic and aromatic series. The inhibiting action is genrally explained by reference to the electrolytic theory of corrosion or to the well known electrochemical laws. According to the electrolytic theory, an organic inhibitor consists of a hydrocarbon radical attached to a highly ionizable atom or group of atoms, and scale and carbides act with iron to form galvanic couples. In the pickling bath, the inhibitor compound is ionized, and the negative radical is driven by coulomb force to the surface of the steel as soon as it is exposed, thus forming a film that increases the cathodic polarization and checks the action of the acid somewhat as in a polorized cell. Most inhibitors contain substances that cause foaming, which prevent the escape of acid with escaping gases and vapors. The prime requirements of an inhibitor are that it must dissolve or disperse colloidally in the bath, prevent hydrogen evolution and must not leave any oily or greasy film on the surface of the steel. To be effective the inhibitor should not break down or decompose rapidly at the bath temperature used, and to be practical the cost per ton of steel pickled must be low. Only a small amount of good inhibitor need be added to the bath to obtain the desired effect."

* * *

BABLIK, in his book "GALVANIZING", (pp. 48-56) has the following to say about inhibitors:

"The chemical preparations usually are highly molecular bodies, sometimes of a colloidal nature, and are usually in close relation to the preliminary and intermediate products of the organic dyes. They are put on the market either in mixture with mineral acids or, if they happen to be solid, mixed with diluents such as sodium chloride or like products.

The effective compounds may belong to: the aldehydes; the nitro-containing compounds where the nitrogen usually occurs as heterocyclic atom; sulphur-containing compounds where the sulphur is linked as a heterogeneous atom, as a mercaptan, or as a sulphide; sulphur-and nitrogen containing compounds such as thioamide, or thioureas, or sulphur - and nitrogen containing heterocyclic compounds such as diazole, diazine, etc. It may clearly be seen that there is a connection between composition and the degree of inhibition, whereby the effectiveness seems to be linked up with the presence of certain atomic groups. An unquestionable influence seems to be exerted by the molecule size, whereby large molecules seem to be especially effective and colloids apparently owe their inhibitive action to their colloidal nature.

The reason for the inhibitive action has not been fully explained. An indication as to the activity of the pickling additions sems to lie in the fact that they cause a very noticeable inhibition, in particular, of the dissolution of metallic iron connected with an evolution of gas.

The beliefs most widely held today are that the pickling additions are adsorbed to the iron and that these substances then increase the overstrain which is necessary for the discharge of the hydrogen."

* * *

TO illustrate how complicated and intricate the study of inhibitors is, we may take an example where four NASCENT HYDROGENS are involved. Nitriles are reduced by NASCENT HYDROGEN to Primary Amines; methyl cyanide yields ethylamine as follows:

$$CH_3C \equiv N + 4H = CH_3\overset{H_2}{\overset{\|}{C}} - \overset{H_2}{\overset{\|}{N}}$$

THUS it is seen that four NASCENT HYDROGENS are taken up in this reaction. Anthracene has been mentioned as being the source of some of the best inhibitors. This compound is classed as a cyclic hydrocarbon and is made up of ten hydrogens linked to fourteen carbon atoms. Just to show how complicated all this can be, a glance at some of the substances found in inhibitor patents will be of interest. There is "Hexamethylenetetramine"; and another which is the condensation product of an aldehyde with an amine; and another which consists of thiobenzamide; and another containing less than 1% by weight of a sulphonated mercaptan; and another containing a small amount of tetramethyl diamino diphenyl disulphide; and still another with a small proportion of an aryl amino derivative of a benothiazole, etc. The point we wish to emphasize and illustrate is that the molecules go from simple reactions involving the taking up of one or a few NASCENT HYDROGENS to very complicated chemical substances which have large molecules and where the reactions may involve perhaps ten, fifteen, or twenty NASCENT HYDROGENS.

* * *

IN addition to these there are still other vast numbers of chemical substances called chlorides, or having the chlorine atom combined with other atoms. During the chemical reactions of pickling the NASCENT HYDROGEN may become joined up with some of these chlorine atoms. There may even be a combination of oxygen, chlorine, and an unsaturated carbon atom to take up the hydrogen. The theory of inhibitors might almost be that a substance that has the power to take up NASCENT HYDROGEN that is liberated in pickling is an inhibitor, and the weak inhibitors are the substances that can only take up a few hydrogen atoms while the strong inhibitors are the very complicated molecules, or big molecules, that have the power to take up many NASCENT HYDROGEN atoms.

* * *

AN extremely important more modern paper on the subject of "Addition Agents", "Inhibitors", and "Brighteners", is the paper, "AN INTERPRETATION OF THE MECHANISM OF BRIGHT ELECTROPLATING", by John A. Henricks, Dept. of Chem. & Met. Eng., University of Michigan, Ann Arbor, Mich., presented at the 82nd General Meeting of the Electrochemical Society, at Detroit. The full text of this paper is found in the article in METAL FINISHING, March, 1943. A large reference list is given with the article.

* * *

THIS paper was written from the viewpoint of the electroplating industry, and it combines the ideas, thoughts, and theories of that industry with the general field of

(*Please turn to page* 542)

Making Wedge Wire Screens of Stainless Steel

Fabrication of Special Screens for Industrial Purposes Requires Stainless that is Uniform and Will Stand Severe Deformation - both Hot and Cold

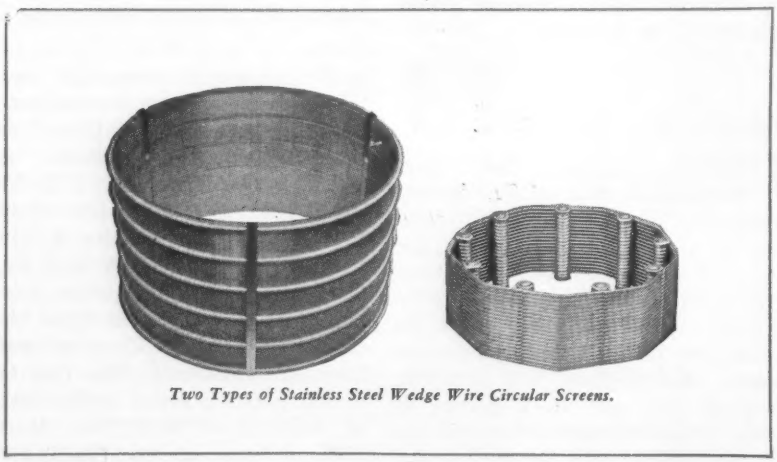
Rustless
DIVISION OF ARMCO

Given a stainless steel which is completely uniform—the kind that the Rustless Iron and Steel Division makes—and an adequate amount of sales engineering, a comparatively small company can fabricate "difficult" products of stainless steel with less trouble than is encountered with most other materials. This is the experience of Wedge Wire Corporation of Cleveland, Ohio, makers of special screens for coal washing and for foods and chemicals, and similar products.

Machinery for making Wedge Wire screening was brought to this country from England only a few years ago. The unique product made with this equipment is attracting wide interest because of several advantages over ordinary wire mesh claimed for certain applications. The screen-wire itself is formed into wedge or other shapes (see next page) to produce controlled openings through which the liquid and screening, Wedge Wire screens are more rigid than ordinary fine mesh.

Wedge Wire screens must be made to close tolerances. To achieve a high degree of control of screening the wire-to-wire openings must be held to plus or minus .002", which means holding the top widths of the wires themselves to plus or minus .001".

The assembly of the screen calls for forming loops at evenly spaced intervals in its wire members and passing tie-rods through the loops of several consecutive wires to form a screen which is rigid and in exact alignment. The loops must mate where the wires cross the tie-rods, to form tight and clog-proof joints. And the inside diameters of the loops must have a close but not binding fit on the tie-rods to form an assembly which is free from play between members but also is free from strain. All of this calls for stainless steels which will deform



Two Types of Stainless Steel Wedge Wire Circular Screens.

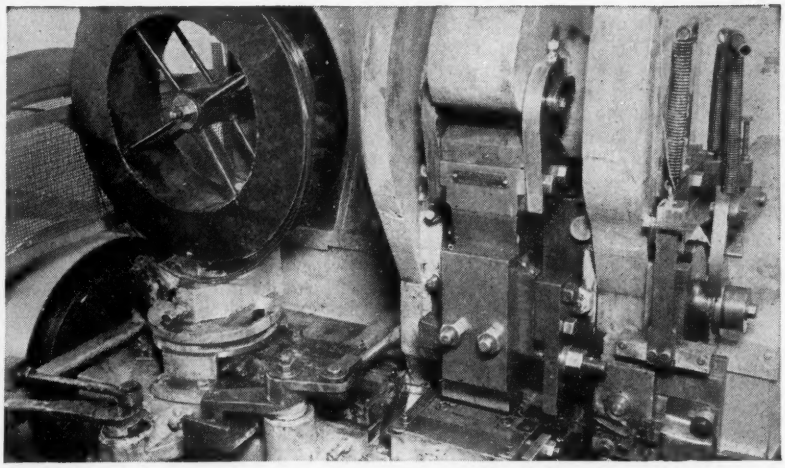
fines being screened can pass. The fact that the surface is almost flat is one reason why Wedge Wire is less apt to clog and thus gives greater production than ordinary screen. The flared contour of the escape passage is also said to produce a desirable orifice and minimize clogging. Furthermore, of fine

to exact tolerances under the dies which form the wire and loop shapes, and which will not spring back or creep appreciably after being deformed.

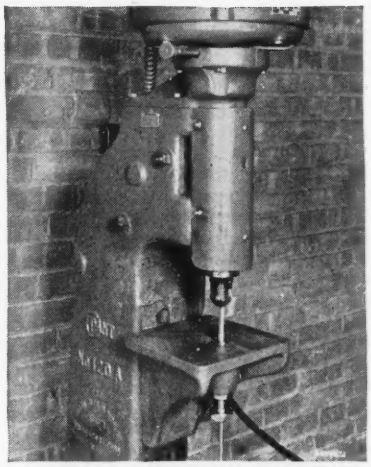
In service the screens are for dewatering, filtering, washing, drying and the separation of materials. A few of the numerous places where they may be placed are in chutes, hoppers, shakers, sluices, drag conveyors and baskets in stationary or moving frames. They are also formed into circular sections for suction filters, centrifugal and rotary screens. While retaining their true form and stiffness under such service, the screens must handle products which may be erosive, corrosive, or both. Wedge Wire screens find wide use in coal, processing plants, chemical plants, food plants, soy-bean and other oil plants, limestone plants and the like. It is because of superior structural and fatigue strength as well as resistance to both erosion and corrosion that stainless steel is used. Stainless steel not only is longer-lived in service, but with its superior mechanical properties increases the kind and amount of stress to which the screens can be subjected and thereby widens their fields of usefulness.

Rustless 17 and 18-12-3Mo, stainless steel Types 430 and 316, are used; Type 430 is preferred for coal plants and Type 316 for chemical and food plants. The material is bought with a thin uniform electrodeposited copper coating, the copper acting as a die lubricant when forming the wires and loops. Generally the copper is not removed since it in no way affects either the performance or the durability of the screen. If it is necessary to remove the copper, this is easily done by dipping in a 10% solution of Nitric Acid. This dissolves the copper but does not affect the stainless.

Production operations include straightening the round wire which has been received in coils; cold forming the loops and cold pressing into the wedge cross section or other shaped members, cold heading one end of each tie-rod, passing the tie-rods through the loops for preliminary assembly, squeezing the wires together along the tie-rods to get the final tight and rigid assembly,



The working Area of the Forming Machine.



Cold heading on a Conventional Type Riveter.

cutting off the tie-rods to length, and hot heading the open end of the tie-rods to hold the wires in place.

Stainless steel shows definite advantages at the first or straightening operation. Straightening is done in a conventional double bending machine, with the wire being wound on special reels to fit the forming machine after the wire has been straightened. One of the purposes of straightening is to take the kinks out of the wire which resulted from possible rough handling in shipment. Once out of stainless these bends do not return as they sometimes do in other metals of which these screens can be made. That is, the proper kind and temper of stainless steel is more readily straightened, and does not spring back. This reduces fabricating costs, since bends in the wire result in stoppages at the forming machine and sometimes in broken dies.

The forming machine loops the wire, forms its cross sections to true and accurate contours, and cuts it to the length needed for the screen, all by fully automatic operations.

The first operation in this machine is forming the loop by winding the wire once around a die pin. Here the complete uniformity of Rustless stainless steel first shows its value. If all of the shipments of wire passing through this process were not alike in both size and temper, then some loops would bind too tightly on the pin so the pin could not be withdrawn to clear them, some would wind too loosely and result in oversize loops which would need special diameter tie-rods for assembly, and some might spring back after winding so that subsequent forming operations would be impossible. With Rustless stainless steel there never is any trouble.

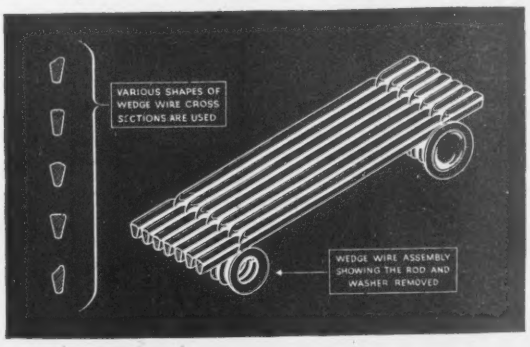
The round wire with loops in place passes to the forming dies. This forming operation is severe. It must produce flat surfaces, concave ones, or convex ones which possess two entirely different radii than those of the original wire, hold one or more dimensions to plus or minus .001″, and deform the wire through about one-third of its original cross-sectional area. The loops also must receive new cross-sectional forms, and these are different from those of the straight sections of the wire. The fact that all this can be done on machines which have only ordinary press actions and which use dies made of ordinary die steels, should relieve many a metal fabricator of the idea the stainless steels are necessarily difficult to work.

Severe forming operations like these cause the metal to flow lengthwise as well as crosswise of the wire. This lengthens the distances between the already spaced and formed loops. Here the complete uniformity of Rustless stainless steel wire provides a second advantage.

Any lack of uniformity in the wire will change the distances which these loops move apart under the forming. Resetting of the machine motions can compensate for some variations in the loop spacings, but any such variations result in increased or decreased over-all lengths of the finished wires since the automatic cut-off mechanism is actuated by a counting mechanism which trips the cut-off after a preset number of strokes of the forming ram and not by anything which takes lineal measurements. The finished wires must come to correct lengths or (if not too bad) be cut to length or else be rejected. Any corrective operations whatever mean loss of machine time and of labor time as well as scrapping materials upon which expensive operations have been performed. With uniform Rustless Stainless Steels these troubles are not encountered.

Completely uniform materials also are important at the cut-off. A steel that is too hard will snap off under the cut-off tool, this tendency being enhanced by the amount of work hardening which the material can receive under the previous severe forming. A material too soft can mush or deform here. Either condition requires a corrective operation if the finished wire is to be salvaged. Completely uniform and correct material avoids this added expense.

Finished Wedge wires run automatically into a gutter of a flat,



metal-topped table. They are transferred to the table top, their loops are aligned, and just enough steel assembly guide pins to hold the wires in alignment are run through a few rows of the loops. Then the wires are transferred to the assembly department.

Primary operation of assembly is to cut stainless steel tie-rods into lengths a few inches longer than the intended widths of the finished screens. This is done in an ordinary power hack saw.

One end of each piece is cold upset to form a head against which the wire loops can bear. This upsetting is done with an ordinary air hammer or in a conventional-type rivet-spinning machine. This company never has had any trouble with upsetting operations on Rustless Stainless Steels.

The Wedge Wire loops are held to close but not extremely fine tolerances. Originally they were held to plus or minus .0015″; an over-all tolerance of .003″. But when experience proved that the inside diameters of the loops were more likely to come undersize than oversize, due to wear reducing size of the winding pin, the tie-rod dimensions were changed to plus .000″ minus .003″, thus bringing all of the tolerance to the minus side.

The fit of the loops on the tie-rods ranges from snug to light press categories, but never a force fit or a drive fit since the loops are desired to be supported but not strained and not to be given any tendency to cock or to deform during the assembly operations. The rods, then, are inserted by hand, the assembly guide pins which had been inserted at the forming machine being withdrawn.

The loose assembly is moved over so the cold-headed rod ends bear against a raised edge of the assembly table. This raised edge is to serve as one jaw of a clamp. The opposite jaw is placed against the free side of the assembly and is tightened toward the raised edge of the table. Tightening the loops together leaves an excess end of tie-rod protruding from the side. This is cut off, an adaptation of a conventional portable pneumatic shear being used for the purpose. Complete uniformity of the rod stock is important to this operation to avoid deformation of the rod ends.

Enough of the excess end is left for final hot upsetting. A stainless-steel washer is placed on this end; the end is quickly raised to red heat with an acetylene flame, and the final hot upsetting is done with a portable compressed-air hammer of conventional type. Rapid air cooling is not detrimental to Types 430 or 316 for Wedge Wire applications.

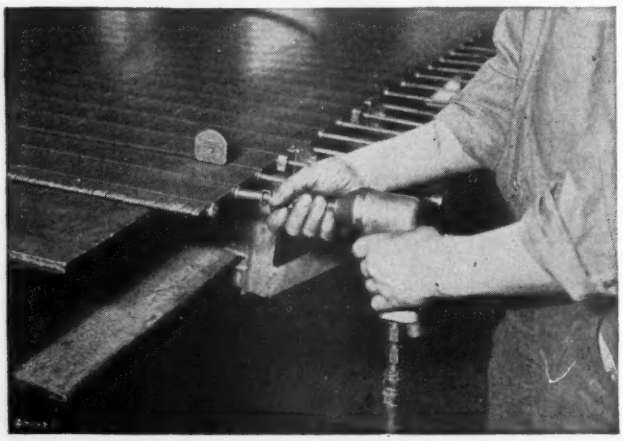
A variation of this assembly procedure is used when the screen is to be curved to be used in a centrifugal or other machine. The "top" surface of the screen can be arranged for the screened material to pass either from the outside to the inside or from the inside to the outside of the screen cylinder. In either case, it is the tie-rods and not the screen wires which must be bent. The bending is done before assembly, the rod-end usually being threaded so that nuts can hold the meeting edges of the screen to a joining member (usually a channel iron) which completes the wall of the cylinder.

A still later variation is to make the screen flat and then curve the rods in a bending brake. Mechanical techniques for this are being developed by a user of the screens but are being kept unpublicized. By such methods the finished screens can be treated as semi-finished raw materials to be formed into many special shapes for better adaptation to special purposes.

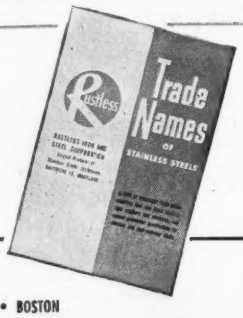
The Wedge Wire Corporation and its customers, then, are able to severely deform and re-deform stainless steels with no special or extra careful handling, no heat-treatments of any kind, no metal cleaning or other "after processes" to prevent corrosion, and almost no manufacturing rejects. They are doing no more than handle it in the offhand manner that would be accorded to "ordinary" metals. They are handling it in a trouble-free way that is made possible first by the excellent fabrication and mechanical properties of stainless steel in general, and second by the complete uniformities of Rustless Stainless Steels. And of all the factors which permit this simplicity of methods, uniformity is by far the most important.

The End.

Final hot upsetting of Rod Ends.



Rustless engineers are glad to work closely wtih those who fabricate stainless steels into industrial equipment or consumer goods. Their cooperation has been invaluable to many firms, which is natural enough since Rustless has never done anything in its entire history except produce, study, learn about stainless, how to machine, forge, heat treat, electropolish, blacken, otherwise work with stainless easily and economically. Much of the Rustless knowledge has been put into printed form. Write for helpful new chart entitled "Trade Names of Stainless Steels."



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Copper And Copper Alloy Springs

PART IV — BEHAVIOUR OF SPRINGS

By The Technical Staff of The Copper Development Association,
London, England

FOREWORD

The design of springs calls for a precise knowledge of the physical characteristics of a material and of the theory of spring behaviour, as well as an accurately controlled fabricating technique.

* * *

As a general rule books and articles on springs deal principally with steel springs, but there are many cases where a non-ferrous spring, and particularly a copper alloy spring, has outstanding advantages.

* * *

Some of the knowledge required for the satisfactory design and production of springs has hitherto not been readily available in a convenient form, and it is the object of the publication of these data to provide information on the use of copper alloys which it is hoped designers and users of springs will find useful.

Stability at Normal Temperatures

THE ideal spring is one in which the deflection is directly proportional to the applied load up to a high stress; in which the same deflection is always obtained for the same load and the same value is obtained whether the load is increasing, or decreasing, and in which the deflection remains constant however long the load is applied. Furthermore the spring should return to its initial position after prolonged deflection when the stress does not exceed the elastic limit, and the zero position should remain fixed indefinitely. A spring never possesses all these desirable characteristics.

* * *

ALL spring materials, whether ferrous or non-ferrous are subject in varying degrees to the following defects which adversely affect their behaviour:

(1) **The modulus of elasticity varies with stress, i.e. within the elastic limit the stress/strain relationship is not linear.**

(2) **The modulus of elasticity varies with time.**

(3) **The zero position of a spring gradually changes with the passage of time independently of any loading—this is generally known as ageing and in the case of a spiral spring usually takes the form of uncoiling.**

(4) **If a spring is deflected by a given load the deflection gradually increases with time and on release of the load the spring fails to return immediately to its zero position though it usually returns if given sufficient recovery time and provided the stress is not too high. This phenomenon is known by various terms such as elastic drift, sub-permanent creep, temporary set, elastic lag, elastic fatigue, elastic after-working, ageing and hysteresis. Carson [26-31] who has done a large amount of work on the subject, calls it elastic drift, and this seems the most satisfactory description.**

(5) **The curve relating load to deflection on increasing stress does not coincide with the curve on decreasing stress. This is known as hysteresis, and has been described as being of three different forms.**

(6) **After passing a spring through a load cycle it does not return to zero but has a positive deflection. On repeating the cycle the difference from zero is smaller and after a few cycles it is reduced to zero. Brombacher [35] calls this "after-effect"; it does not appear to be very different from the elastic drift described in (4) above.**

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Published in Four Parts—
Part I Design Of Springs
Part II Manufacture of Springs
Part III Characteristics of Spring Materials
Part IV Behaviour of Springs

THE importance of the above effects depends on the purpose for which the spring is used. For the majority of uses probably none has any serious bearing, but all are liable to be of significance when springs are used in any form of measuring apparatus. Examples are fluid or gas-operated diaphragms and capsules of various kinds, and spiral springs for electrical indicating instruments. Of the defects probably (4) has the largest effect; it is of such importance with electrical instruments as to require limitation by Specification. (See B.S. 89, "Electrical Indicating Instruments", Clause 28.)

* * *

Change of Modulus with Stress

THE data on the variation of modulus with stress are based very largely on Sayre's work [32, 33], though the phenomenon is confirmed by C. S. Smith [34] and according to Anderson in the discussion on Smith's paper, if the true stress/strain relationship is a straight line the stress/strain relationship as normally plotted, i.e. uncorrected for change of diameter and gauge length, must be a curve. Sayre's results determined on hard-drawn phosphor bronze wire having 5% tin and on 70/30 brass having a tensile strength of 53 tons/sq. in. are shown in Fig. 14.

Ageing

IN addition to the change of modulus with stress and the change with temperature (referred to below) the modulus also changes with the passage of time. According to Carson [29] the change may be either

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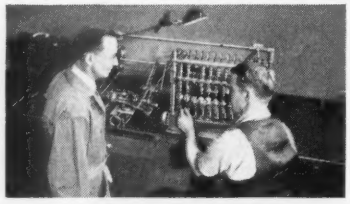

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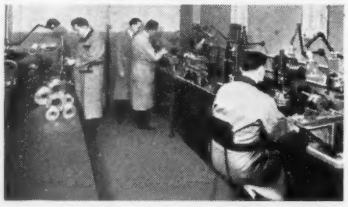

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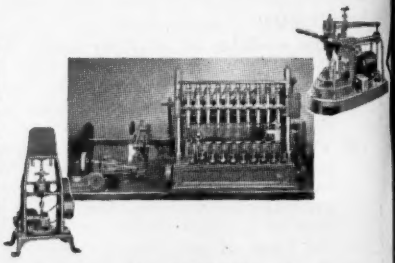

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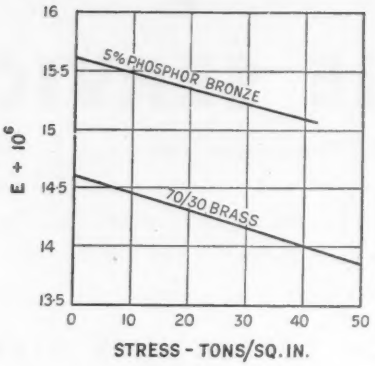

Fig. 14.—Effect of Stress on Modulus of Elasticity (Sayre).

an increase or a decrease, though the former is usually the case and the increase may be as much as 5%. Internal stresses are responsible for these changes and their relief by low-temperature heat treatment, such as that described in the section on the manufacture of spiral springs, is the best method of overcoming the trouble. Such treatment may increase the modulus of phosphor bronze by 1 to 2%. The internal stresses are, of course, due to the deformation which occurs in making the spring, and the trouble is increased by "surging", already described, in which the spring is given an overstrain with a view to increasing the safe working load.

Movement of Zero Position

THE change of modulus with stress and time is also accompanied by a change of zero position which has for long been a source of trouble with electrical instruments; it is dealt in a Bureau of Standards Circular published in 1915. Carson states that spiral springs may uncoil as much as 10 degrees of arc and the spring torque may increase as much as 5%. As the temperature increases the rate of uncoiling goes up rapidly as shown in Fig. 15. This result clearly indicates that low-temperature heat treatment should overcome this trouble and Carson suggests 100° C. for 24 hours. During such treatment some uncoiling takes place, but none occurs subsequently at normal temperatures. It is not obvious why this should have any different effect from the setting operation which involves heating spiral springs to about 300° C. for some hours (further details in Part II). If this setting operation is carried far enough there should be no residual stresses which will give rise to zero creep and change of modulus with time. Helical springs, diaphragms and elastic bellows are not, however, generally given this setting operation and doubtless Carson's treatment would be suitable in such cases.

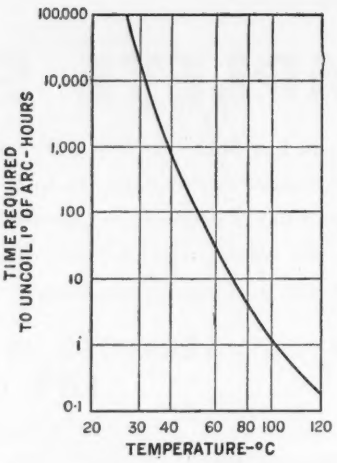

Fig. 15.—Effect of operating temperature on the rate of uncoiling a phosphor bronze spring (Carson & MacGahan).

Elastic Drift

THE phenomenon of elastic drift is closely associated with creep, though creep is generally assumed to be permanent, i.e. the extension is entirely plastic, but this is seldom strictly correct. The higher the temperature and stress, the larger the ratio of plastic to elastic extension, which explains why the phenomenon appears to be different at normal temperatures where most of the extension is recoverable, as compared with creep at high temperatures which is almost entirely irrecoverable.

Table 11. TEMPERATURE COEFFICIENT OF THE RIGIDITY MODULUS AND OF YOUNG'S MODULUS OF ELASTICITY[39]

Material	Composition, per cent	Condition of Specimen	Temperature Coefficient per ° C. of Rigidity Modulus × 10^5	Temperature Range, ° C.	Temperature Coefficient per ° C. of Young's Modulus × 10^5	Temperature Range, ° C.
Beryllium Copper	Be 1·9, Cu 98·1	Hardened	— 33	— 50 to 50	— 35	— 50 to 50
Brass	Cu 61·9, Zn 35·5, Pb 2·6	Hard drawn	— 46	— 20 to 50	—	—
	Cu 63·3, Zn 34·8, Pb 1·75	Hard drawn	— 52	— 20 to 50	—	—
	Cu 73, Zn 26·9, Pb 0·02	Hard drawn	— 39	— 50 to 50	— 39	— 50 to 50
Nickel Silver ..	Ni 9·8, Zn 25·4, Cu 64·8	Hard drawn	— 39	— 50 to 50	— 38	— 50 to 50
	Ni 10·5, Zn 27·4, Cu 61·7	Hard drawn	— 37	— 50 to 50	— 35	— 50 to 50
	Ni 14·2, Zn 23·5, Cu 62·2	Hard drawn	— 38	— 50 to 50	— 35	— 50 to 50
	Ni 15·3, Zn 24·2, Cu 60·4	Hard drawn	— 39	— 50 to 50	— 35	— 50 to 50
	Ni 15·5, Zn 26·2, Cu 58·0	Hard drawn	— 44	— 20 to 50	—	—
	Ni 18·4, Zn 17·0, Cu 64·5	Hard drawn	— 37	— 50 to 50	— 35	— 50 to 50
	Ni 19·3, Zn 16·2, Cu 64·4	Hard drawn	— 38	— 50 to 50	— 35	— 50 to 50
	Ni 19·3, Zn 16·2, Cu 64·4	Annealed	— 34	— 50 to 50	— 33	— 50 to 50
	Ni 15·5, Zn 26·2, Cu 58·0	H.D., T. 200° C.	— 42	— 20 to 50	—	—
	Ni 15·5, Zn 26·2, Cu 58·0	H.D., T. 300/650° C.	— 36 to — 38	— 20 to 50	—	—
Phosphor Bronze	Sn 3·9, P 0·2, Cu 95·8	Hard drawn	— 48	— 20 to 50	—	—
	Sn 4·3, P 0·4, Cu 95·3	Hard drawn	— 41	— 50 to 50	— 38	— 50 to 50
	Sn 5·1, P 0·29, Cu 94·6	Hard drawn	— 38	— 50 to 50	— 40	— 50 to 50
	Sn 4·6, P 0·29, Cu 95·0	Hard drawn	— 40	— 50 to 50	— 36	— 50 to 50
	Not given	Hard rolled	—	—	— 38	— 20 to 80

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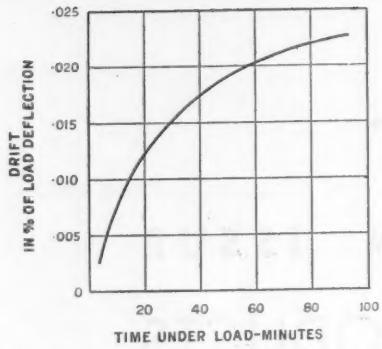


Fig. 16.—Drift of Beryllium Copper, heat-treated at 343° C. for 20 mins. Bending stress 26.8 tons/sq. in. (Carson).

THE magnitude of elastic drift depends on the stress to which a spring is subjected and the time for which this stress is maintained. The actual movement is very small and requires accurate devices such as the electronic micrometer for its measurement. Fig. 16 shows the drift of heat-treated beryllium copper subjected to a bending stress of 60,000 lb./sq. in. It will be seen that after an hour drift was 0.02% of the load deflection. The rate of drift diminishes with time, but does not appear to fall to zero, as can be seen from Fig. 17, which shows the same results plotted logarithmically. These curves are characteristic of non-ferrous metals. On the release of stress the spring does not return to its initial position immediately, and the longer the time it has been stressed the longer the time it takes to recover. This is illustrated in Fig. 18, which applies to a flat phosphor bronze spring strip loaded to a strain of 0.0008. It will be seen that a drift of 0.07%, after loading for one hour, is recovered after about two hours, but recovery from a drift of 0.27% which develops after applying the same load for 25 hours, takes about six weeks.

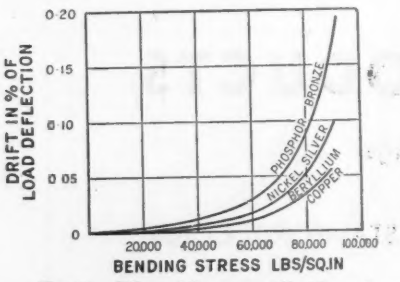


Fig. 19.—Effect of Stress on drift (Carson)

THE effect of bending stress on drift for three typical spring materials is shown in Fig. 19, which indicates an advantage for beryllium copper. It must be borne in mind, however, that the beryllium copper tested had been heat treated so as to produce minimum drift, whereas apparently the other two alloys had not undergone any stress relief treatment. Furthermore, the time and temperature of heat treatment to produce minimum drift may not produce optimum characteristics in other respects. From these curves, Carson has deduced that the drift is proportional to the stress raised to the power 5.3 for all these materials, though in view of the limited amount of work which has been done on drift all the results should be regarded as qualitative rather than quantitative.

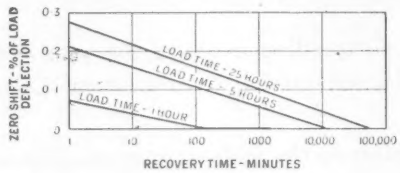


Fig. 18.—Effect of load time on the elastic recovery of Phosphor Bronze Spring Strip (Carson & MacGahan).

* * *

CARSON states that the low-temperature heat treatment of 100° C., for 24 hours, which he recommends for overcoming ageing, will also eliminate elastic drift. It has also been suggested that the trouble may be minimised by "exercising" or "seasoning" the spring, i.e. by loading and unloading it several times. If this is so it should be carefully distinguished from "surging" which is a deliberate overstraining, producing an elastic strain at the outer fibres in an opposite direction to the normally applied stress. Thus the maximum permissible load which may be applied without exceeding the elastic limit of the material is increased. Such a process induces internal stresses which are the chief cause of zero drift and therefore, whilst "surging" may be useful for load-carrying springs, it would be detrimental to instrument springs.

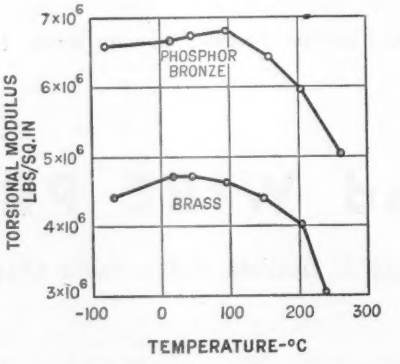


Fig. 20.—Effect of temperature on torsional modulus of non-ferrous metals (Zimmerli, Wood & Wilson).

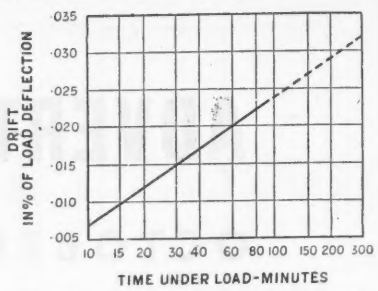


Fig. 17.—As Fig. 16, but time scale plotted logarithmically.

* * *

Hysteresis

HYSTERESIS and drift can readily be distinguished. The former is for all practical purposes instantaneous and is the difference between deflections for ascending and descending loads of the same magnitude. Applied to an instrument with several moving parts the phenomenon can in its crudest form be described as "backlash", but for a single spring fixed at one end and deprived of all auxiliary items such as bearings which might cause hysteresis, the phenomenon can only be due to a curved stress/strain re-

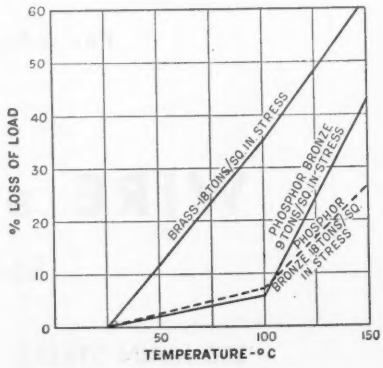


Fig. 21.—Loss of loading capacity of Springs through heating (Zimmerli, Wood & Wilson).

lationship. Brombacher's tests [35] referred to above appear to have been devoid of any extraneous complicating features (they were made on helical compression springs). He found that seasoning the spring by loading and unloading it a hundred times did not have any appreciable effect on the hyteresis, though presumably several loading cycles were effected before making measurements to overcome the "after-effect" described below. Sayre has given a rational explanation of drift and hysteresis based on molecular conditions within grains and on disturbed conditions at grain boundaries. For full details see Reference 33.

* * *

ACCORDING to S. K. Wood [36] there are three types of hysteresis: (a) mechanical hysterisis due to external causes such as friction and the "backlash" referred to above, (b) hyper-elastic hysteresis which occurs when a material is stressed beyond the elastic limit, and which is due to plastic changes, and (c) hypo-elastic hysteresis, which occurs when the stress lies within the elastic range and is due to internal friction within the material. This is clearly the hysteresis measured by Brombacher.

* * *

After-Effect

BROMBACHER defines "after-effect" as the difference in readings for zero load at the start and conclusion of a load cycle. His tests were made on helical compression springs and he found that after about three cycles the zero error was negligible. Seasoning appears to have had very little effect on the phenomenon, which presumably reappears after a rest period. The tests were made as quickly as possible, but this does not necessarily eliminate the possibility of elastic drift.

* * *

Effect of Elevated Temperatures

YOUNG'S Modulus and the rigidity modulus for most metals fall with increase of temperature, and as a result the stiffness of a spring diminishes. The temperature coefficient for most copper alloys lies generally within the range —.0.0003 to — 0.0005 per °C., i.e. 0.03 to 0.05% per °C. Thus a modulus of 20×10^6 lb./sq. in. would fall to a value between 19.0% 10^6 and 19.4×10^6 lb./sq. in. for a rise of temperature of 100°C. Such a change has small influence on the behaviour of springs in many cases, but the changes should not be overlooked where springs are exposed to high temperatures or where parts not normally regarded as springs may, in fact, be acting as such. In these cases the pressures induced will be modified by increase of temperature involving both expansion and modulus changes.

* * *

WHERE springs are used in measuring devices such as altimeters, pressure gauges, accelerometers, electrical instruments, and are exposed to wide temperature variations — such as occur in aeroplane instruments which may have to operate satisfactorily over a range of — 50° F. to + 150° F. — the effect of temperature on modulus may be of vital importance.

* * *

TESTS on hard-drawn straight wires of phosphor bronze and brass by Zimmerli, Wood and Wilson [37] are illustrated in Fig. 20. It will be seen that in both cases the torsional modulus has a maximum value and falls both with increase and decrease of temperature. The composition of the phosphor bronze was 96% copper, 3.7% tin and of the brass 66% copper and 33.5% zinc. These results conflict with others made a few years later by the Bureau of Standards [38] using an arrangement whereby the variation of both the elastic and the rigidity modulus with temperature could be measured.

* * *

THIS work, which was of a very comprehensive nature involving the testing of springs made from more than thirty different materials, was carried out on behalf of the National Advisory Committee for Aeronautics. A summary of the results for copper alloys, together with a few determinations by other workers, is shown in Table 11. It will be seen that for all practical purposes the same value of coefficient applies to both Young's Modulus and the rigidity modulus. The coefficients vary with temperature — the value at 25° C. being, for the copper alloys, 2% higher than the value at — 25° C. This change is so small that the figures given may be taken as applicable to any atmospheric temperature. Although this work is subsequent to that of Zimmerli, Wood and Wilson, and conflicts with it in some respects, the authors do not comment on the fact. In view of the shape of the curves shown in Fig. 20 it would be unwise to assume that the coefficients obtained by the Bureau of Standards are necessarily applicable over a wider range of temperature than ± 50° C.

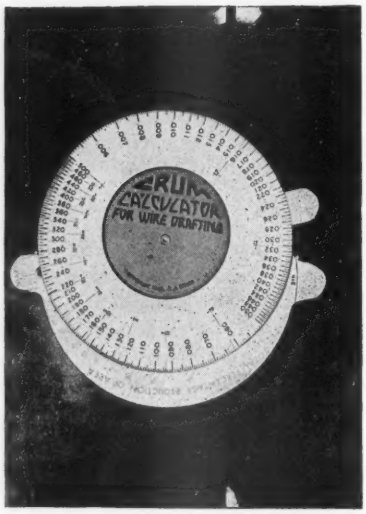
* * *

WHEN springs are loaded and held at an elevated temperature for a long time they are liable to experience permanent set, loss of stiffness of loading capacity. Examples where such behaviour may occur are engine valve springs, clutch springs and oven door springs. Zimmerli, Wood and Wilson [40] have examined this loss of loading capacity by compressing small springs of different material and heating them to various temperatures for 72 hours. Among the materials used were phosphor bronze and brass, the composition being 94.2% copper, 5.51% tin, and 66.6% copper, 32.9% zinc respectively. The results are shown in Fig. 21, from which, it is apparent that even at 100° C. there is some loss of loading capacity which increases steeply for phosphor bronze above 100° C. The stresses shown are the total shear stresses calculated by the Wahl formula (see Part I). These results should be regarded as qualitative since there appears to be some deficiency of data, and furthermore the springs were, previous to test, subjected to some unspecified heat treatment involving a temperature of 200° C. for the phosphor bronze and 260° C. for the brass. In addition it will be seen that the two phosphor

(*Please turn to page* 559)

The Crum Calculator for Wire Drafting

Provides answers simply and accurately for a given mathematical wire drafting problem. One setting shows number of holes, percentage of draft per hole, total reduction in area and intermediate die sizes to be used. Covers drafting range of .500″ to .005″. Accurate enough for most mill conditions.



Simple to operate; compact enough to carry in vest pocket; can be used for Metric as well as English systems; all diameters given in decimals. A handy and time-saving device that will eliminate time-wasting and possible errors in calculations.

Instructions, containing examples, will be furnished with each calculator.

Order yours today.

HOW TO ORDER

The price is $5.00 each. A discount of 10% on ten or more.

Send check or purchase order to

WIRE AND WIRE PRODUCTS

300 MAIN STREET **STAMFORD, CONN.**

Oakite Announces New Rust Preventive

ANNOUNCEMENT of a new product for the prevention of rust on ferrous surfaces between operations and while parts are in storage is made by **Oakite Products, Inc.**

* * *

KNOWN as **Oakite Special Protective Oil,** it has already found wide use in many plants where temporary or semi-permanent surface protection from rust is desired for parts or work, following such operations as grinding, machining, pickling, tumbling, sand blasting, brazing, etc.

* * *

THE oil imparts a thin, transparent, rust-preventive coating which does not interfere with accurate gauging or stain or discolor ferrous surfaces. Metal to be rustproofed either may be immersed dry, or because of its water displacing properties, may be immersed immediately after cleaning and rinsing, while parts are wet, thereby eliminating the necessity for drying surfaces, prior to applying rust-preventive.

* * *

A 16-page booklet describing the many industrial applications of this product is available upon request to Oakite Products, Inc., 52 Thames Street, New York 6, N. Y.

* * *

Carbide Laminating Dies Outlast Steel Dies 50 Times; Eliminate Burring

A FIFTY-FOLD increase in punch and die life, together with the complete elimination of undesirable burring of the blanked metal, are gains reported by a California concern, following installation of punches and dies of cemented carbide for the manufacture of stator laminations for electrical motors.

* * *

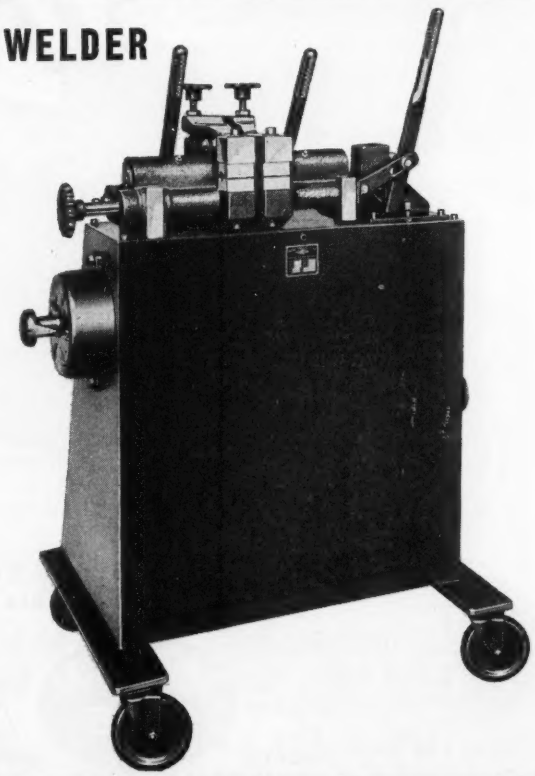
THE operation at this plant involves piercing laminations in Electric and Armco grade annular steel discs having a 2.50% silicon and a .12% carbon content. Stock is between .016" and .018" thick. Laminating is performed on an indexing V.O. press operating at a speed up to 600 strokes a minute. No lubricant is used in this punching operation.

* * *

THE carbide dies in current use at the plant, are identical in construction to the steel dies formerly employed. They are made in two pieces and clamped together. The die is sharpened by grinding metal off the top. Relieving each half of the die after grinding maintains correct size. Only the sides of the dies have clearance; the ends are straight. The face of the punch is concave, giving it a shearing action. This reduces the load which the punch must take at any instant since different sections of the punch cut the metal at different intervals during the blanking operation. The load on the press is also reduced, thereby. Carboloy Grade 55B, a shock resistant grade of carbide in general use for blanking work, is used for both lamination punches and dies.

MICROMETER PRECISION — MICRO-WELD — TRADE MARK REG. U. S. PAT. OFF.

MODEL H-T MICRO-WELD HEAVY BUTT WELDER



A general utility Butt welder for welding Steel (low carbon) rods and wire ranging in size from 1/8" to 7/8" diameter.

While this unit was not designed for production line work, the wide range in welding capacity make it suitable for various types of welding requirements.

Equipped with hand-operated toggle type clamping mechanism, providing positive clamping of the stock.

Spring actuated movable welding headpiece and close coupling of the transformer provides high efficiency on the welding current.

General construction of this unit is rugged to resist high upsetting forces, and to maintain accurate alignment of the work.

Furnished mounted on 4-wheel truck as illustrated.

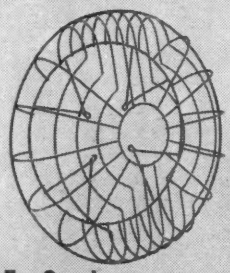
MICRO PRODUCTS COMPANY
20 NORTH WACKER DRIVE
CHICAGO 6, ILL.
Telephone: State 7468

Attention Getters

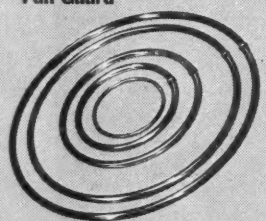
CHICAGO WIRECRAFT* Display Racks

Chicago Wirecraft Company, Chicago, 22, Ill.

Other Important Uses for Keystone Wire in Chicago Wirecraft Products



Fan Guard



Reinforcing Rings for Grinding Wheels

made with **KEYSTONE**

Wire

Displaying a product "up front" is an important point in successful merchandising . . . display racks by Chicago Wirecraft are *proved* sales builders.

Other wire products by Chicago Wirecraft are highly regarded, too, because they deliver sure quality and performance. Some of these wire products call for strength . . . others stiffness, corrosion resistance, flexibility and toughness.

Naturally, proper wire for the job is important . . . reason enough why special Keystone wire is used. Regardless of the gauge, analysis or finish of wire required, Keystone can normally supply it.

We are indeed proud that Keystone wire has been chosen to add its bit to the quality of Chicago Wirecraft products.

KEYSTONE STEEL & WIRE CO.
PEORIA 7, ILLINOIS

Special Analysis Wire for All Industrial Uses

SAMSON SPRING WIRE
KEYSTONE STEEL & WIRE CO. PEORIA, ILL.

Coppered, Tinned, Annealed, Galvanized

Thermoplastic Insulated Building Wire with Maximum Load Capacity and High Resistance to Heat Engineered by FTR

A THERMOPLASTIC insulated building wire for general purpose wiring in both dry and permanently wet locations is being manufactured by **Federal Telephone and Radio Corporation,** Newark, New Jersey, associate of International Telephone and Telegraph Corporation. This wire has proven its ability, in a series of exacting laboratory tests, to meet the special and unusual requirements of industry and the building trades. It is long lived, high in dielectric and tensile strength, and stable under all operating conditions of moisture and temperature.

* * *

FEDERAL'S building wire comes in two types. Both types have a maximum operating temperature of 60°C for application on switchboards, within appliances, in recognized metal raceways where exposed to oil, and within appliances where exposed to oil. Type "TW" is for use in permanently wet locations.

* * *

THE wire is ideally suited for new wiring or rewiring installation, for maintenance jobs or complete wiring systems. Because of its small diameter, space is saved, and in rewiring jobs the capacity of old conduits and raceways is increased, at times as much as 450 per cent.

* * *

IT is flexible and has a glass-smooth finish which makes it easy to pull through ducts. Because it will not support combustion, fire hazard is greatly reduced through the use of Federal's wire. Solid or stranded conductors, either tinned or bare are available.

* * *

THIS wire is supplied in various colors and complies with the construction and test requirements of the "Standards for Thermoplastic Insulated Wires" of Underwriters Laboratories, Inc.

Wire Association San Francisco, California Regional Meeting

THE Annual Pacific Coast Meeting of The Wire Association was held at the Sir Francis Drake Hotel, San Francisco, California, Friday, June 7th, 1946.

* * *

AN interesting original paper entitled "Inhibitors — Their Development and Use" was presented by Wallace G. Imhoff, Consulting Galvanizing Engineer of Los Angeles, California, at the dinner meeting, followed by a sound motion picture on "Swaging" by the Standard Machinery Company of Providence, Rhode Island. An excellent dinner with an attendance of 35 preceded the meeting.

* * *

THE committee in charge was under the chairmanship of Earl W. Potter, Manager, Industrial Wire Products Company, division of K. H. Davis Manufacturing Corporation, San Francisco, California, who also acted as chairman of the meeting.

* * *

PRESENT also was the Executive Secretary, Richard E. Brown, in order to build up interest in membership in the West Coast Chapter of the Wire Association of which this was the third annual meeting, the other two having been held in San Francisco in 1944 and in Los Angeles in 1945.

* * *

C.P.A. Gives Priority Assistance to Makers of Magnet Wires

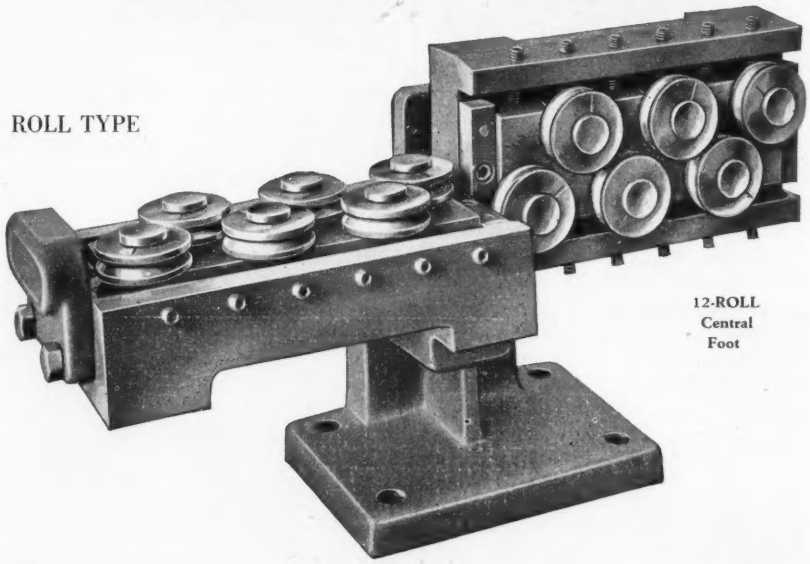
COPPER magnet wire has been classified in critically short supply by the Civilian Production Administration, which will grant priorities assistance to maintain or increase their production.

* * *

COPPER magnet wire is used for electric motors, transformers, ignition coils, telephone, telegraph and teletype equipment, radio sets, hagnetos and hundreds of electrical products including refrigerators, washing machines and vacuum cleaners.

TWO WIRE STRAIGHTENERS
WITHOUT CUTTING ATTACHMENTS

ROLL TYPE



12-ROLL Central Foot

The Roll Type design shown above is generally used with automatic machines. The wire is drawn through the straightener to remove the natural curve and put it into better shape for the forming dies. Made in sizes from 1/16" to 1/2".

The Rotary machine shown below has no feeding attachment. The wire is pulled through mechanically while the head revolves at high speed. Made in sizes from 1/16" to 3/8".

In the case of either of these machines, the size indicates the maximum diameter of wire that can be handled, but several smaller sizes can also be worked.

Glad to send further information. It will help us in recommending a suitable material for the dies if, writing us, you give the diameters and kinds of wire you wish to straighten.

ROTARY TYPE

THE F. B. SHUSTER MFG. CO., INC., NEW HAVEN, CONN.

SHUSTER SINCE 1866

Automatic WIRE STRAIGHTENING AND CUTTING MACHINES

Outstanding Personalities of the Wire Industry

John C. Callahan Retires as Works Manager of the Steel Company of Canada, Ltd.

ANNOUNCEMENT is made at this time of the retirement of John C. Callaghan as Works Manager of the Canada Works of The Steel Company of Canada, Ltd., effective June 15. Mr. Callaghan, however, will remain with the company in an advisory capacity. This retirement comes after thirty-eight years of continuous service with The Canada Works of The Steel Company of Canada, the necessity for which is Mr. Callaghan's health.

* * *

IT is with pleasure that The Wire Association announces the fact that Mr. Callaghan will stay with the Company in an advisory capacity as this will enable him to continue his membership of many years in the Association. Mr. Callaghan has a host of friends in the steel industry in the United States, Canada and Europe, and is most favorably known and liked for his work in The Wire Association of which he is a charter member. His sound advise and considered opinions have been of immesurable value to the Association. We know that all his fellow members and friends will join in wishing him many years enjoyment of his well earned leisure and look forward to the pleasure of seeing him at all Wire Association meetings.

Richard E. Brown,
Executive Secretary

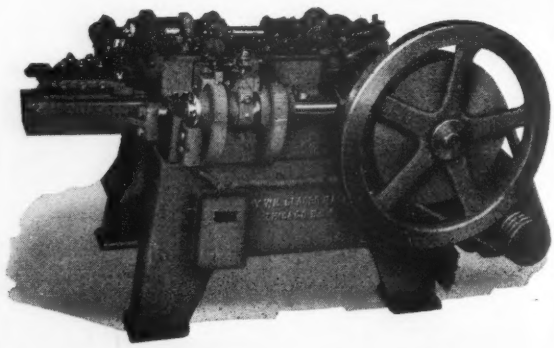
John S. Callaghan, Canada Works, Steel Company of Canada, Ltd.

* * *

Darrow Honored on Anniversary

JAMES A. Darrow, general superintendent of the Joliet Works of the **American Steel and Wire Company** received a gold medal commemorating his fiftieth year of wire making. Mr. Darrow's service to the industry began in 1896 at the Waukegan plant of the Washburn and Moen Manufacturing Company which was taken over by the American Steel and Wire Company in 1899, two years before the

GLADER HIGH SPEED WIRE NAIL MACHINE



MACHINE ARRANGED FOR INDIVIDUAL MOTOR DRIVE

High tonnage output, and low maintenance costs, have resulted in Glader Machines being accepted as standard equipment in every large nail mill built in the United States in the past twenty years.

Glader Machines are operating in most of the wire producing mills throughout the world.

These machines are made in eleven different types and sizes. This enables us to cover the range of sizes of nails produced with the greatest efficiency.

For further information please address,

WM. GLADER MACHINE WORKS

210 No. Racine Ave.
Chicago 7, Illinois

wire company became an integral part of the United States Steel Corporation. In 1936 he was made general superintendent of the Joliet Works leaving his position as assistant general superintendent at Waukegan.

Steel Executive Dies

W. A. GIVENS, 60, of 224 S. Homewood Avenue, Pittsburgh, executive vice president and director of **Allegheny Ludlum Steel Corporation**, died Wednesday, May 29, in Allegheny Valley Hospital, Tarentum, following a cerebral hemorrhage suffered in his office at Brackenridge.

* * *

MR. Givens came to Allegheny Steel Company in 1925 as superintendent of the Merchant Mill after many years of operating experience with other steel companies. In 1926, he was promoted to alloy production manager and two years later was appointed general superintendent, a position he held until 1932 when he was made general manager. In 1938, he was elected to the board of directors and was made vice president in charge of manufacturing. In 1944, he was elected executive vice president.

J. C. Belden, Jr., Elected Secretary of Belden Mfg. Company

JOSEPH C. BELDEN, Jr., son of the late founder of the **Belden Manufacturing Company**, manufacturer of electrical wire and cable, has been elected secretary of the company, replacing **Albert Beutler** who retired after 44 years with the organization. The change was voted recently at the postponed annual meeting of the board of directors. All other officers were re-elected.

* * *

MR. Beutler, who was elected secretary in 1933, was the first employee of the company, and he has been associated with it continuously since 1902. He designed the original insulating machinery first used by the company, and some of his machine designs are still recognized as the most efficient available in the wire and cable industry.

* * *

MR. Belden has been assistant secretary for the past year, a post to which he was appointed on his discharge from the navy after two and a half years of active service. He held the rank of lieutenant. Mr. Belden has been a member of the board of directors since 1937.

* * *

ADVERTISING is a service to a magazine's readers. Methods, materials, and machinery were developed under the stress of war. Both editorial matter and advertisements keep you informed on what is happening in industry.

TECO Cemented Carbide reduces time and production losses caused by too-frequent die changing. Correct size and finish are held for longer runs, producing greater tonnage per day, per die, per machine.

TECO Cemented Carbide has greater resistance to wear and friction because — made to rigid standards — it is harder, denser, more uniform. Let a test run prove that it's profitable to put these smooth-wearing, slow-wearing dies on the "business end" of your machines. Our engineers are glad to discuss your requirements.

WIRE and BAR DIES
SIZING DIES—EXTRUDING DIES
TUBING DIES

Carbide Blanks, Tools, Bits,
Reamers, Broaches, Forming Tools

TUNGSTEN ELECTRIC CORPORATION — 564 39th St., Union City, N. J.
Branch Office: 403 Western Reserve Bldg., Cleveland 13, Ohio
Representative: Architects & Builders Bldg., Indianapolis, Ind.

TECO — Pioneers in Tungsten Carbides for over a Quarter Century — CARBIDE DIES

Jones & Laughlin Steel Corp., Aliquippa Works, Appoints N. A. Hansen to Succeed John C. Aiken as Assistant Superintendent

ANNOUNCEMENT is made by the **Aliquippa Works** of **Jones & Laughlin Steel Corp.** of the appointment of **N. A . Hansen** as Assistant Superintendent to succeed **J. C. Aiken.**

* * *

MR. Hansen was born at Bemus Point, N. Y., and graduated from the University of Pittsburgh, receiving his M.E. degree in 1924. In November 1926 he entered the employ of Jones & Laughlin Steel Corporation in the Industrial Engineering Department from where he went to the Wire Department of the Aliquippa Works, Rod Mill Division in April 1929.

* * *

ON February 1st, 1935, Mr. Hansen became Foreman of the Bundling Room and Galvanizing Department foreman in June 1939. In 1942 he was made General Foreman of the Wire Department where he remained until his appointment as Superintendent of the Wire Department on May 1st, 1946.

N. A. HANSEN of J. & L.

OVEN ENGINEERING NEWS

Write for These Technical Bulletins on Oven Engineering Installations

The battle of costs is a battle that never ends. Present day problems dictate the policy of constantly surveying your existing facilities for materials-handling as well as your oven-processing systems, in order to keep your manufacturing costs at a profitable level.

The Industrial Oven Engineering Company designs, engineers, manufactures and installs complete materials-handling and oven-processing systems for many different industries.

These installations are described in the pamphlets listed below. They are well illustrated with photographs and drawings. A good many of these installations are probably applicable with slight variation, to your own processing problems.

These pamphlets are free. They are briefly described below. Check off the ones you want and drop us a line.

☐ **Blueprint for Industry, Part III**—Complete engineering information on our constant-speed, constant-tension windup machine for wire, cable, textile, tape, coated fabrics and other continuous materials, the only machine of its kind on the market.

☐ **Lacquering of Insulated Wire and Cable**—A 16-page reprint of a thorough going article on cable lacquering techniques and equipment, originally published in the trade magazine "Wire and Wire Products". Illustrated with drawings.

☐ **How Will You Choose Your Drying Oven?**—A description of the role of the infra-red lamp in modern drying ovens.

☐ **Blueprint for Industry, Part II**—A comprehensive 18-page brochure on high-production ovens for many batch and continuous heating processes. In addition to detailed descriptions and engineering details of many efficient oven-materials-handling systems, it contains two pages of engineering data on gases and other materials, along with fan engineering data.

ENGINEERING VERSATILITY

THE INDUSTRIAL *Oven Engineering* COMPANY

13825 TRISKETT ROAD, CLEVELAND 11, OHIO

* ASSOCIATED COMPANY: JAMES DAY MACHINERY LTD., LONDON, W. 1, ENGLAND *

Two New Appointments Announced in G-E's Industrial Engineering Division

TWO new appointments have been announced in the **Industrial Engineering Divisions** of the **General Electric Company** by **J. D. Wright,** manager of the divisions, **H. W. Poole** has been appointed Engineer, Steel Mill Division, and **C. M. Rhoades, Jr.,** has been named Engineer, Machinery Division.

* * *

Carl O. Bruestle, Director of Research of Syncro Machine Company

CARL O. BRUESTLE, with the **Syncro Machine Company,** Perth Amboy, N. J., since its formation, has been promoted to the newly created position of Director of Research for the company and its affiliated divisions.

* * *

CARROL E. ORR, formerly Electrical Engineer for the company, will succeed Mr. Bruestle as Chief Engineer.

Send in Your Order for the 1946 Wire Buyers Guide

A Review of Recent Wire Patents

No. 2,399,631, COIL WINDING FORM, patented May 7, 1946 by John Gartner, Hasbrouck Heights, N. J., assignor to Bendix Aviation Corporation, Teterboro, N. J., a corporation of Delaware.

This device includes a number of grooved, turn-receiving posts extending from one face of a panel. One of the posts is mounted to move relative to the others, and an impaling pin is carried by the panel for fastening an insulating head thereto for the coil.

★ ★ ★

No. 2,399,745, METAL DRAWING APPARATUS, patented May 7, 1946 by Wallace E. Kerr, Youngstown, Ohio.

While more specifically adapted to draw bars, this assembly includes a carriage mounting a pair of blank-engaging grippers movable theron and relative to each other in engaging a blank and also mounting an element for engaging the carriage moving device. The grippers are adapted to move relative to the carriage frame and to each other upon initiation of movement of the carriage away from a work head comprising a member fixed in relation to this head and a member connected with the grippers and positioned within the frame, and a releasable connection between these members.

★ ★ ★

Complete Description and Drawings of Patents May Be Had for 25 cents outside the United States and Canada $1.00. Address, Wire & Wire Products, 300 Main St., Stamford, Conn.

No. 2,400,323, WIRE STRANDING MACHINE, patented May 14, 1946 by Albert E. Winslow, Norwich, Conn., assignor by mesne assignments, to Farrel-Birmingham Company, Incorporated, Ansonia, Conn., a corporation of Connecticut.

The assembly includes a creel carrying a number of supply packages of wire strands, a hollow spindle through which the strands extend, a twister and layer for the strands, a device to false twist the laid strands in the same direction to set the helical lay of the strands in the formed cable, means to oppositely flex the cable to remove kinks therefrom, a device to engage and feed the cable, a measuring device and means to reel the cable.

★ ★ ★

No. 2,400,417, WIRE CARRIER FOR WORKMEN, patented May 14, 1946 by John P. Hickey, Columbus, Ohio.

A harness is provided for carrying wire, including shoulder straps, with guides thereon to train the wire over the shoulders of the wearer and thence to the front.

★ ★ ★

No. 2,400,573, INHIBITORS, patented May 21, 1946 by Carl F. Prutton, Cleveland Heights, Ohio, assignor to one-half to Albert Kelvin Smith, Shaker Heights, Ohio.

This is a non-aqueous composition for inhibiting corrosion of metal surface and comprises phosphorus having an oil-solubilizing organic radicle with a separate organic derivative of a phosphorus-free inorganic acid, in an oil vehicle.

★ ★ ★

No. 2,400,739, APPARATUS FOR SUPPLYING WIRE FROM WIRE SUPPLY SPOOLS TO BENDING PRESSES, patented May 21, 1946 by James S. Burge, Anderson, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware.

There is a cluth connection between the spool shaft and drive shaft, to permit the former to overrun the latter, with a device to disengage the clutch and render a spool-stopping device effective.

★ ★ ★

No. 2,401,070, HARDWARE AND SCREEN CLOTH MACHINE, patented May 28, 1946 by Noah S. Harter, Waukegan, Ill., assignor to The American Steel and Wire Company of New Jersey, a corporation of New Jersey.

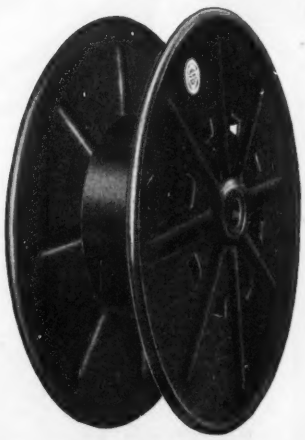
(*Please turn to page* 558)

MOSSBERG PRESSED STEEL CORP.

Greater service from a new All Welded Steel Take Off Reel designed to meet present day requirements.

Usual maintenance expense eliminated by adoption of this new design wherein all parts are welded into one homogeneous unit.

Reel sides are embossed with radial reinforcing ribs for increased rigidity with rolled edges for additional strength and to facilitate handling.



All Welded Steel Take Off Reel

Complete line of spools and reels for both processing and shipping all kinds of bare and insulated wires and cables. (Send for Catalogue W-104)

MOSSBERG
Pressed Steel Corp.
18 WEST STREET
ATTLEBORO, MASSACHUSETTS, U. S. A.

James Day (Machinery), Ltd., "Ford House," 88 Regent Street, London, W. I., England.

A Review of Inhibitors

(*Continued from page* 523)

pickling that has already been discussed. The viewpoint is very much broadened by this excellent paper, and serves to further emphasize how very complicated this whole subject of inhibitors is.

* * *

Referring to his industry he opens his paper with:

"However, the remarkable effect of the addition of certain organic compounds to electroplating baths to produce lustrous deposits has long been an unexplained phenomenon. The effect of purely crystalloid addition agents of unrelated chemical composition such as furfural used in cadmium cyanide baths; sulfonic acids, sulfonamides, and aldehydes used in bright nickel baths; carbon disulfide used in silver cyanide baths, or the sugars used in acid zinc and copper solutions, has led to a clouded and vague chemical picture that has reduced research on the subject to cut-and-try experimentation."

* * *

FOR the interpretation of organic addition action he presents the following hypothesis:

"We wish to show that bright plating in the presence of organic addition agents is brought about by a mixture of organic bases and inorganic colloids in the cathode film, that transform normal deposition to a periodic phenomenon, reduce the grain size of the depositing metal, and restrain perpendicular grain growth by their adsorption."

* * *

HENRICKS states that previous interpretations of organic addition action can be divided into four general groups as follows:

1. **ADSORPTION THEORY. W. D. Bancroft in 1904, and more extensively in 1913. He states, "The crystal size is decreased when there are present at the cathode surface substances which are adsorbed by the deposited metal.'**
2. **REDUCING AGENT THEORY. E. F. Kern in 1909 stated, 'The function of an addition agent in an elctrolyte is to maintain a reducing menstruum around the cathode, which, in turn, causes the deposit to form denser and smoother."**
3. **COMPLEX ION THEORY. This theory was first proposed by F. C. Mathers in 1916, and elaborated by him in 1939. It stated, "that effective addition agents form complex ions with the depositing metal".**

HENRICKS believed that the deductions are false and misleading, and suggests that the grain refinement is caused by the precipitation of colloids in the cathode film.

4. **CATHODE INTERFERENCE THEORY. L. B. Hunt in 1932. Hunt concluded that: 'the crystalline structure of an electro-deposited metal will be governed by the relation of the metal ion concentration in the cathode film to the concentration of the other constituents of that film.**

* * *

HENRICKS states, "We believe that cathode interference is responsible for grain refinement in electrodeposition, and hope to show that such interference is the result of colloidal formation and adsorption at the cathode film. He also suggests that for the plating industry the term "addition agent" is misleading, and suggests that the word "brightener" be used instead. He then states that a brightener can be defined as any substance which, when added to the electroplating bath, will produce an electrodeposit with a specular reflection superior

to the specular reflection of the basis metal.

* * *

HE notes that Louis Kahlenberg and H. N. Huntzicker investigated electrolytically hydrogenated nickel cathodes and found they could completely reduce potassium permanganate, arsenic to arsine; precipitate a black immersion deposit of nickel from a normal nickel sulphate solution, and even yield a trace of ammonia gas from gaseous hydrogen.

* * *

HENRICKS' statements are so in agreement with the writer's views that giving the fullest credit to him, some, in fact many and much of his material is quoted so that theories and viewpoints offered in conclusion, can be more clearly seen and understood. Continuing, he states, "Numerous electrodeductions are indicated in the case of nickel brighteners. Polynitro compounds, such as picric acid, can be reduced to amino phenols in a nickel plating bath, and certain compounds, such as anthraquinone sulfonic acid or quinine sulphate, can reduce the current efficiency of nickel deposition by preferential depolarization to a point where only a fraction of the Faraday equivalent of nickel is deposited. Potent unsaturated nickel brighteners, such as furfural, and cinnamaldehyde, are reported to be resinified undercathodic reduction. Perhaps the most important reduction in this group is that of the aromatic sulfonic acids used in many bright nickel baths. Aromatic sulfonic acids are reduced to aromatic mercaptans. This reduction is of importance for two reasons: (1) aromatic mercaptans are insoluble and may exist as adsorbable colloids in the cathode film, or precipitate insoluble nickel mercaptides therein; (2) both aryl and alkyl mercaptans are powerful mercaptans acid pickling inhibitors enjoying wide commercial use.

TURNING once again to the theory of inhibitors Henricks' statements are of utmost importance to any one wishing to study the mechanism of operation of these materials in acid pickling baths. He states:

"The theory of the action of acid pickling inhibitors is somewhat controversial. C. A. Mann and others reason that these oxygen, sulfur, nitrogen, or nitrogen and sulfur compounds form positive quaternary ions in acid solution which are adsorbed on bare cathodic areas of local cells or couples to prevent further attack upon steel. Willy Machu, however, in a study of gelatin as an inhibitor, claimed that the action was entirely an adsorption phenomenon, and that quaternary ion formation was uncertain. The correctness of either theory is not important to this discussion, but the fact that all organic nickel brighteners are either acid inhibitors or compounds reducible to acid inhibitors is of importance. The ubiquitous proteins, such as gelatin and albumin, which brighten and embrittle nickel deposits, as well as deposits from acid and cyanide zinc and cadmium baths, and from acid copper, tin and lead baths, are also efficient acid inhibitors. The following nickel brighteners are also cited in the literature as pickling inhibitors; sulfonated napthalenesl

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formaldehyde; acetaldehyde, furfural and benzaldehyde; thioureas and substituted thioureas; tri aryl methane dyes; alkaloids; gum tragacanth and gelatine; selenous acid; glucose; hexamethylenetetramine probably formed cathodically in cobalt-nickel baths containing formaldehyde and ammonia."

* * *

ANOTHER extremely important statement by Henricks which the writer has started out as a basic theme in this discussion is that acid pickles in steel are REDUCING IN CHARACTER. He states:

"We have found that acid pickling efficiency tests upon steel in sulfuric acid offer a valuable means of evaluating potential nickels brighteners, since the acid pickle is a reducing medium and the steel offers an active surface of adsorption. It is believed that the action of an organic nickel brightener is similar to that of an acid pickling inhibitor in that both are organic sulfur nitrogen, or quaternary salt-forming compounds that are adsorbed on an active metal surface to form an insulating layer. The following mechanism is assumed for the action of these compounds as nickel brighteners.

A nickel crystal at an active center attains a higher potential than surrounding crystals. This higher potential causes the electrolytic reduction of adjacent brightener to an inhibitor which is adsorbed to form an insulating layer, which temporarily halts growth. The adjacent crystals, uninhibited, continue growth until each in turn increases potential to the reduction point, and likewise becomes filmed with inhibitor. When in this manner the entire surface is filmed, the cathode reaction shifts to nickel deposition, after which the adsorption cycle is repeated."

* * *

Discussion and Comments by the Writer

ONE thing seems to be very outstanding, namely, that the subject of "inhibitors" is indeed an extremely complicated and complex thing. The fact that so many theories have been offered and discussed by outstanding authorities indicates that because so many substances have been found, that the number of different theories and the difference of opinions may have a basis primarily to be found in the inhibitor substance tested. It appears to the writer that the theories and opinions set forth by the various investigators are correct for the specific substances tested, and since we have already shown that there are hundreds of substances, many very different from the others, it would appear that a broad explanation covering all of them, if that is possible, might throw still further light on the subject. The present state of understanding might be compared perhaps to the old familiar story of the seven blind men of India, each one that had felt a different part of an elephant, and each one from his experience, could describe exactly how the elephant as a whole looked. The one who had touched the elephant's side was sure that it must be like a great long wall, but the man who had felt only one of his legs was just as sure that the beast was like a round column. They were all right, but it took their leader who could see, to tell them what the whole animal looked like, so each one could understand the nature of the part he had touched, and what relation that part bore to the whole elephant. We have tried to review the subject by carefully looking at the various "parts"; it may be possible to gain some very valuable information by trying to put the "parts" together. An at-

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tempt will be made to do this hoping that "some kind of animal worth while" will result. This attempt will be made from the angle and viewpoint of the action and use of inhibitors in pickling baths for iron and steel; the electroplating industry may find something of value, or perhaps a new idea regarding the subject from their angle, or viewpoint.

* * *

A summary and restating of some of the most valuable things discussed is submitted below for inspection and as ideas and material to be further analyzed.

1. Acid pickling solutions or sulphuric acid on steel are very powerful reducing solutions, as indicated by the always present ferrous sulphate.

2. NASCENT HYDROGEN formed by the pickling reaction is a most powerful reducing agent.

3. Scales and iron oxides on steels, from hot working, consist of the black iron oxides, Fe0 and the black magnetic oxide of iron; the bright blue ferric oxide of iron; the blue ferric silicate, a combination of the blue ferric oxide and silica; and varying amounts of metallic iron that have been rolled up into, and mixed with the iron oxides and scales.

The cold iron oxides and scales formed by corrosion of the steel consist of the yellow ferric oxides (limonites) with varying amounts of chemically combined water; ferric hydroxide; ferric carbonate; and varying amounts of the red and brown platey ferric oxides, ordinary rusts).

4. Inhibitors are inorganic and organic substances which are added to the pickling bath for the purpose of retarding the chemical action of the acid on the steel, while allowing it to continue on the iron oxides and scales until they are dissolved, or removed, and the steel surface is perfectly clean.

5. Inhibiting action is the reducing action of NASCENT HYDROGEN on the inorganic and organic substances added to the pickling bath for the purpose of protecting the steel while the oxides and scales are being attacked and removed by the acid.

6. The method of accomplishing the protection of the steel while the acid is attacking and dissolving and removing the iron oxides and scales is both chemical and mechanical in character, the actual means and material depending upon the inhibitor substance.

7. Since sulphuric acid does not attack silica, silicate scales are not dissolved by the action of the acid, but probably are removed when the iron oxides around them are dissolved, and they are left free to drop off, or be washed off by the pickling solution.

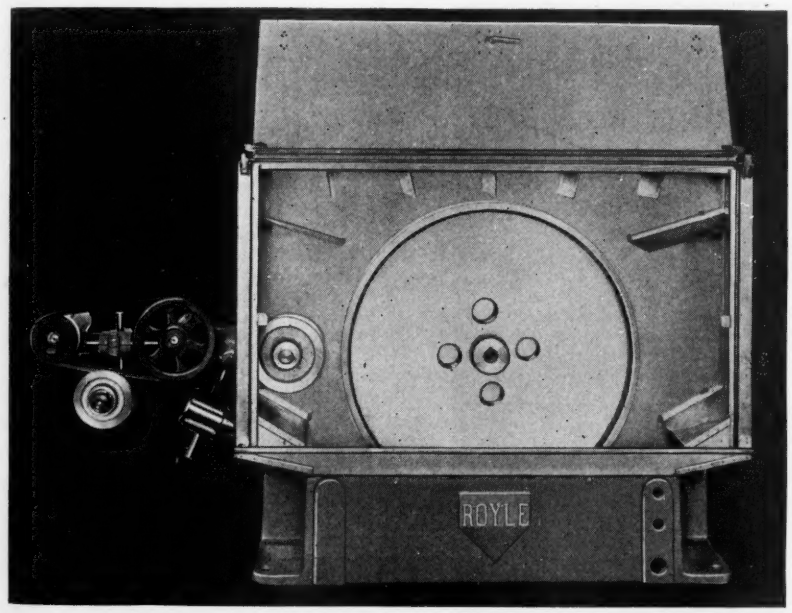
8. Ionization is the basis for the chemical reactions, or medium through which they operate. Since the silicate scales are not ionized, there is no action on them. When iron goes into solution it takes on positive charges of electricity.

9. When ionization of the acid takes place the hydrogen takes on two positive charges, one positive charge on each hydrogen atom. When the hydrogen ion gives up its charge it becomes a gas, and escapes from the pickling solution.

10. The results of the action of inhibitor substances in the pickling with the NASCENT HYDROGEN are expressed as—

a. The reduction of the inhibitor substance (conversely, expressed by the oxidation of the NASCENT HYDROGEN by the inhibitor substance). Free hydrogen is rapidly oxidized by nitric acid; formaldehyde is reduced to methyl alcohol (Formaldehyde oxidizes the NASCENT HYDROGEN).
This action may result in the formation of water or the hydroxal radical; the formation of water takes up two hydrogen atoms; the formation of hydroxal, one. The total number of hydrogen atoms involved depends upon the inhibitor substance, and the complexity of the molecular structure.

b. The reduction of the inhibitor by the NASCENT HYDROGEN may free a metal, by losing its electrical charge in the chemical reaction. When the hydrogen ion loses its positive charge it escapes as a gas, or tends to migrate to the cathode (iron in pickling); when the metal loses its positive charge it tends to deposit out on the cathode as a covering material or film. Thus the



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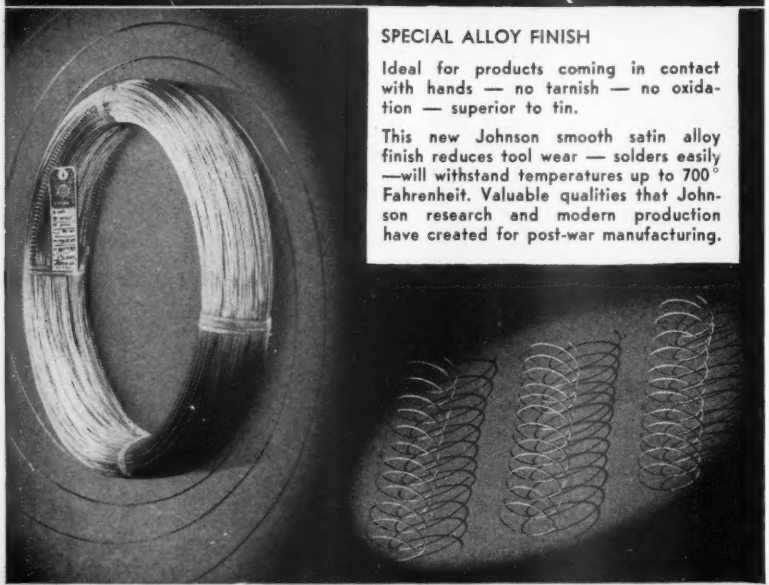

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attack of the acid is retarded on the iron (steel), while the attack continues on the iron oxides and scales. Metals are simple ions in this illustration.

c. The reduction of the inhibitor by the NASCENT HYDROGEN may free a complex ion, which when it loses its positive charge comes out as colloidal substance which like hydrogen, metals, and all those materials which cannot escape as a gas, migrate over to the cathode, where they deposit as colloidal films covering the cathode areas.

d. The reduction of the inhibitor by the NASCENT HYDROGEN (oxidation of the NASCENT HYDROGEN by the inhibitor substance, may consume a small number, or a very large number of hydrogen atoms depending upon the simplicity or the complexity of the molecular structure of the inhibitor substance) may consume a few or many hydrogen atoms.

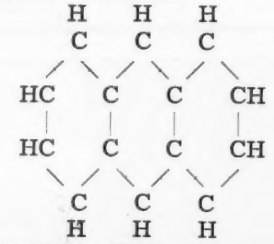
* * *

ILLUSTRATION:

$$2HNO_3 + 2H = 2H_2O + 2NO_2$$
$$2HNO_3 + 4H = 2H_2O + 2HNO_2$$
$$2HNO_3 + 6H = 4H_2O + 2NO$$
$$2HNO_3 + 8H = 5H_2O + N_2O$$
$$2HNO_3 + 10H = 6H_2O + N_2$$
$$2HNO_3 + 16H = 6H_2O + 2NH_3$$

Free hydrogen is rapidly oxidized by nitric acid.

The chemical formula of anthracene illustrates the hydrogen atoms of organic inhibitors.



ANTHRACENE — $C_{14}H_{10}$

e. The reduction of the inhibitor by NASCENT HYDROGEN furnishes hydrogen atoms for unsaturated organic compounds. These compounds may simply take up the hydrogen and hold it in combination with some radical, or it may form the hydroxyl radical of the compound, or it may form an entirely new reduction organic compound which throws out, or discharges a colloidal substance that forms a film over the cathode areas when it loses its charge of electricity. Henricks states — "Potent unsaturated nickel brighteners, such as furfural, and cinnamaldehyde, are reported to be resinified under cathodic reduction. Perhaps the most important reduction in this group is that of the aromatic sulfonic acids used in many bright nickel baths. Aromatic sulfonic acids are reduced to aromatic mercaptans. This reduction is important for two reasons: (1) aromatic mercaptans are insoluble and may exist as adsorbable colloids in the cathode film, or may precipitate insoluble nickel mercaptides therein; (2) both aryl and alkyl mercaptans are powerful acid pickling inhibitors enjoying wide commercial use."

ACKNOWLEDGMENT: The writer is a metallurgist and not an expert or well known authority in organic chemistry. I therefore wish to take opportunity to express my thanks and grateful appreciation for being able to draw freely, and often quote in full large passages from the papers of many other fin investigators, research chemists and authorities in the field of inhibitors. I am particularly indebted to Mr. Alfred Douty, Mr. John A. Henricks, Mr. F. P. Spruance, Dr. Carl A. Zapffe, (Bibliography; 46 references) Mr. O. L. Thomas, Mr. James P. ApRoberts, Mr. Rodman R. Tatnall, Mr. H. G. Hobbs Mr. William M. Parkin, and to the many companies who have sent the writer their booklets, bulletins, phamplets, and information on inhibitors, as well as the text books on chemistry, both organic and inorganic, that have aided me in gathering together, and preparing this discussion. It is hoped that both the steel industry and the plating industry will be benefited from the time and effort in preparing the discussion. I am particularity grateful to Mr. Richard E. Brown, and to The Wire Association for the honor they have bestowed upon me in asking me to present this article and paper on "The Review of Inhibitors", at their meeting in San Francisco on June 7, 1946.

* * *

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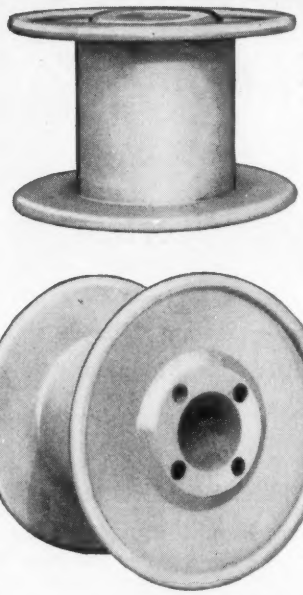

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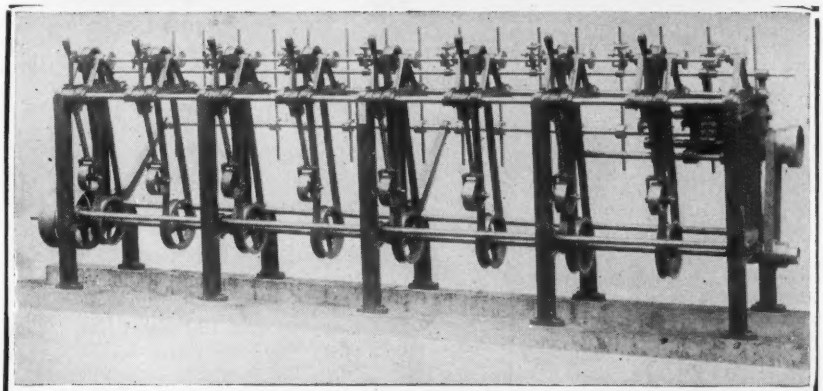

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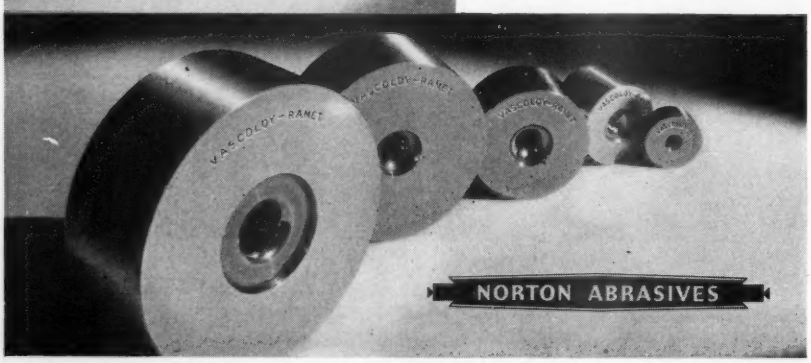

Microhardness Testing of Fine Wire and Small Parts

(*Continued from page* 518)

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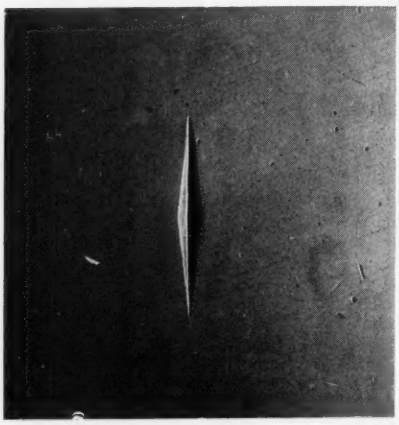

Fig. 12.—Knoop indentation on surface of jewel in Fig. 11 (X 800). Load of 0.3 kilogram.

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1. Frederick Knoop, Chauncey G. Peters, and Walter B. Emerson, "A Sensitive Pyramidal-Diamond Tool for Indentation Measurements", National Bureau of Standards, RESEARCH PAPER RP 1220, July, 1939.
2. Vincent E. Lysaght, "Microhardness Testing of Materials", MATERIALS AND METHODS (formerly METALS AND ALLOYS), Vol. 22, No. 4, October, 1945.

3. Vincent E. Lysaght, "The Knoop Indenter as Applied to Testing Nonmetallic Materials Ranging from Plastics to Diamonds", ASTM BULLETIN No. 138, January, 1946.

ACKNOWLEDGMENT is due the Hamilton Watch Company for support of this work and for the use of the Tukon tester. Special credit is due to Mr. H. M. Cobb, Jr., Sr. Metallurgist, and Mr. Wm. M. Stokes for their co-operation and interest in the project. The material and the tests which are mentioned in this article have been prepared by these men. It should be remembered that tests of this type are made with extreme difficulty due to the smallness of the parts and also due to the fact that the mineral materials fracture excessively under all but the very lightest loads.

We are also grateful to Mr. M. N. Rivenburg for his comments and criticisms of the original manuscript.

★ ★ ★

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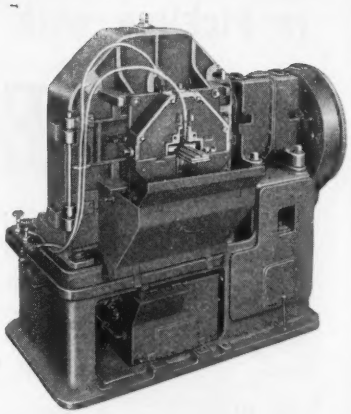

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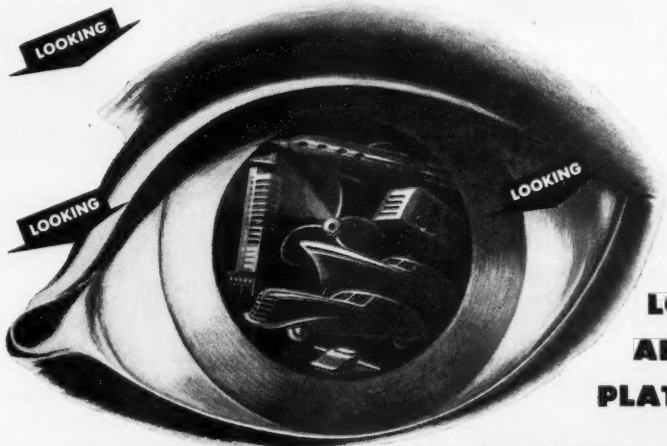

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* * *

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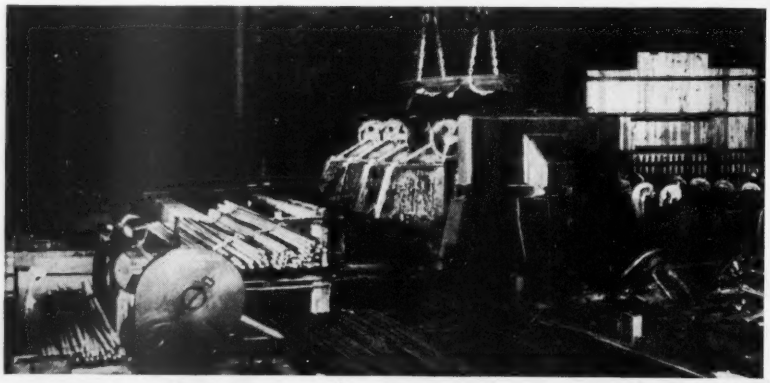

New Weldco Pickler in operation at Superior Drawn Steel Company plant, Monaca, Pa.

IT is possible to fit this equipment into any type plant. It can be built to any capacity, and the only tonnage limitation is the limit of the individual company's handling equipment.

* * *

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SEND IN YOUR ORDER NOW for the 1946 WIRE BUYERS GUIDE

New Thy-Mo-Trol Equipment Facilities Winding of More Than 4000 Miles of Wire Daily

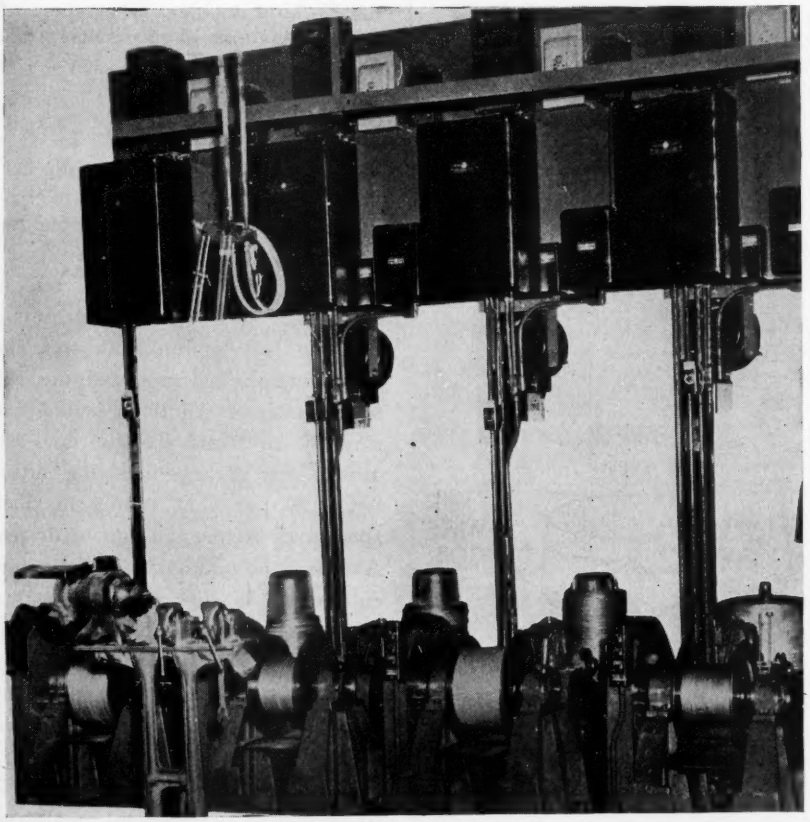
WIRE production at **Jones and Laughlin's Wire Rope Division,** Muncy, Pa., has been more than tripled per winding line since the mechanical equipment was redesigned and four 1-hp and four 2-hp G-E Thy-mo-trol wire-winding units were installed. Taking 0.041-in. wire as the average, the eight new wire-winding lines and the remaining older lines now wind 80,000-125,000 lb, or well over 4000 miles of wire, in a 24-hr period.

* * *

PREVIOUSLY all wire at this plant had been wound on group-winding machines, each consisting of six winding bobbins and six unwinding swifts. The bobbins were driven by one constant-speed induction motor, through line shafts, gears, and individual disconnecting clutches, so that the wire speed increased as the wire continued to build up on the bobbin. The disadvantages of this arrangement were low average winding speeds, the difficulty of obtaining uniform winding tension, and high mechanical maintenance, since a breakdown on one machine put six lines out of order.

* * *

WITH the new equipment, the bobbin motor on each of four lines is rated 1 hp, 690/1380 rpm, 230 volts, d-c, while those on each of the four lines used for winding heavier wire are rated 2 hp, 1150/2300 rpm, 230 volts, d-c. The swift motor, which normally functions as a drag generator, is normally rated from one-fourth to one-third the rating of the bobbin motor. The



4 Typical Wire Rewinding Lines. View Showing Bobbins in Front and Unwinding Swifts in Rear. "Thy-MO-Trol" Electronic Control Cabinets Shown Mounted Overhead.

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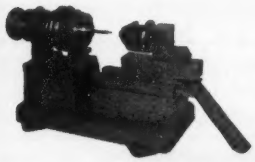

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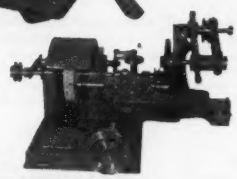
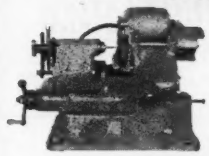


NEW ROOS PIN GRINDER



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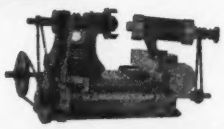

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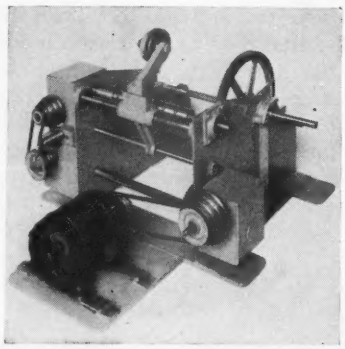

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* * *

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* * *

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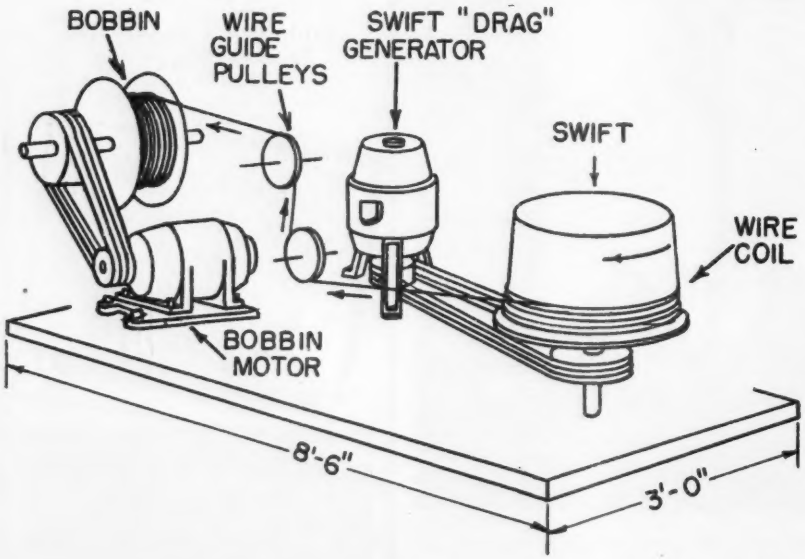
wire leaves the swift at an almost constant unwinding radius. That is, the loose wire coil is thrown on the swift in such a manner that the inner wrap of the coil is "peeled" off the swift at the bottom inside "corner" of the swift core at a linear wire speed directly proportional to the swift rpm. The swift generator is loaded on an adjustable braking resistor. Thus, the swift generator controls wire tension and indicates wire speed.



Arrangement of Typical Thy-Mo-Trol Wire Rewinding Equipment

* * *

THE new electronic equipment regulates the speed of the bobbin motor, making it possible not only to operate at higher wire speeds than were formerly used, but to hold wire speed constant throughout the full bobbin build-up. The new controls are mounted directly above each of the lines, which are side by side and parallel to each other. This arrangement has effected a 50 per cent saving in floor space over the previous group drives. Another advantage of the new equipment is that wire is wound more tightly and uniformly, with more wire per bobbin and fewer breaks. Moreover, limit switches stop each line when the end of the wire leaves the swift and thus relieves operators for other duties. In addition, mechanical maintenance costs have been materially reduced.

New Office Building and Warehouse for John A. Roebling's Sons Company of Illinois

THE **John A. Roebling's Sons Company** of Illinois announces that work is already well underway in the erection of a modern office building and warehouse. The new building has been designed with provision for future expansion, and is located at 5525 West Roosevelt Road, Chicago. The structure is designed and located to facilitate material handling and expedite customer service. The site selected will provide exceptional transportation advantages, because of the proximity of inbound and outbound freight facilities for all railroads entering and leaving the Chicago area.

* * *

Blaw-Knox Company Acquires Supertherm System

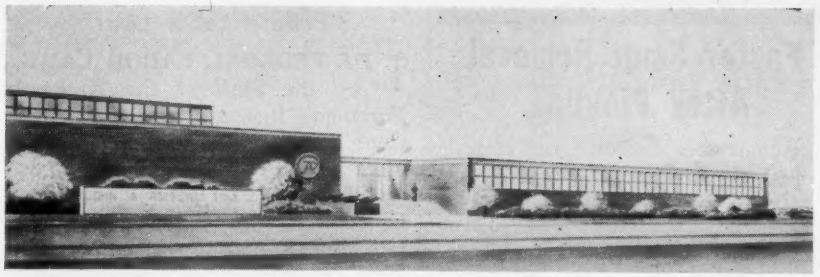
ARRANGEMENTS have been completed whereby the **Blaw-Knox Company** of Pittsburgh takes over from the **J. O. Ross Engineering Corporation** of New York all engineering, sales, fabricating and installation of the Ross Supertherm Hot Water Heating System in North and South America.

* * *

THE Supertherm system which utilizes super heated water for industrial heating was originally promoted in Europe by a company associated with the J. O. Ross Engineering Corporation and it has proved extremely successful. Hundreds of the most prominent plants in a variety of industries throughout Europe have proved the advantages of using hot water instead of steam for process heating and it is today the accepted heating method in such industries as aircraft, chemicals, automotive, rayon, rubber, cable, cosmetics, cement, meat packing, household appliances and others.

* * *

IN the short period prior to the opening of the war, the Ross organization had installed the Ross Supertherm System in many prominent plants in major industries here, among them being the General Electric Co., Industrial Tape Corp., Behr Manning Corp., Synthane Corp., Universal Plastics Corp., Wickwire Spencer Steel, General Motors Overseas Operations, Personal Products Corp., Wallace Laboratories and others. In Canada, the system has been installed in such plants as Phillips Electrical Works, Ltd., Marine Industries Ltd., and Sorel Industries, Incorporated.



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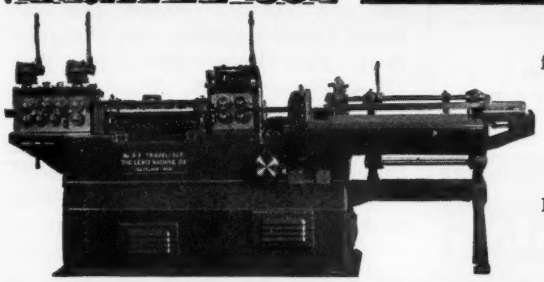

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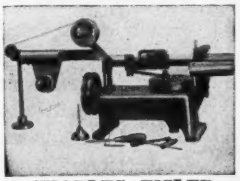

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Federal Labor Laws

THE FEDERAL LABOR LAWS, by the Staff of the National Foremen's Institute, of Deep River, Conn., is a manual needed by foremen who have been stumped by the growing mass of Federal labor legislation with which they are expected to deal. It will be particularly welcomed by management which pays for the errors of omission and commission by foremen who are ignorant of the laws governing their relations with their workers.

* * *

IN one convenient slim manual the foreman can now find the information he needs — the important do's and don'ts, — about: The National Labor Relations Act (Wagner Act), Fair Labor Standards Act (Wage-Hour Law), Walsh-Healey Public Contracts Act, Wage Stabilization, Social Security Act, U. S. Employment Service, Fair Employment Practices Committee, Veterans' Legislation.

* * *

THE salient points of each law are presented concisely in simple, non-legal language, and interpreted from the foreman's point of view. For example the section pertaining to the Wagner Act covers: Rights of Employees, Interference, Company Unions, Discrimination, Complaint Against the Employer, Collective Bargaining, Enforcement, Majority Rule. In the section about the Wage and Hour Law is covered: Minimum Wage, Deductions from Wages, Hours of Work, Overtime Compensation, Calculating Overtime Pay, Exceptions to Overtime Pay Provision, Child Labor, Records, Enforcements and Penalties, Coverage, Status of Foremen.

* * *

AN outstanding feature of this manual is that, wherever possible, actual case-histories are presented that show the typical application of the law, and make it easy for the foreman to understand the law in terms of his own experience. Another valuable feature: the manual is loose-leaf, and inserts covering new labor laws or revisions to

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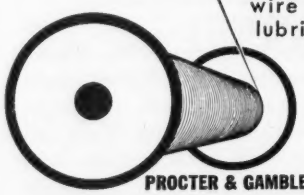

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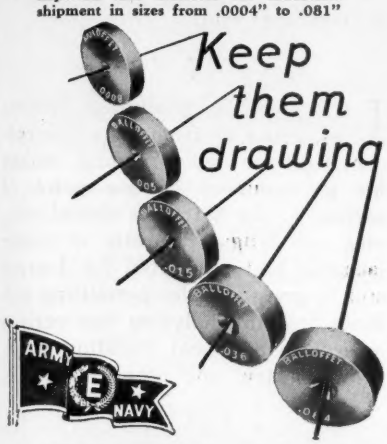

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The Dobeckum Company Announces Expansion Program

T. F. Dolan, President of **The Dobeckmun Company,** Cleveland, Ohio, announces an expansion program involving a new factory building in Berkeley, California and a substantial addition to the Cleveland Plant at 3301 Monroe Avenue. C. P. A. approval of both projects has been secured from district offices in San Francisco and Cleveland respectively.

* * *

NEW production space at both locations is about 50,000 square feet each at a total cost of $525,000, including real estate in Berkeley. Employment thoughout the company is now double the 1941 average, with the expectation of further personnel growth as raw materials become freer.

* * *

THE Dobeckmun Company has long pioneered in the conversion of cellophane, aluminum foil, and other flexible packaging materials. As this new space and added facilities become available, it will be much better equipped to keep pace with the expanding demand for its packaging products.

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THE new Berkeley, California Plant will be located at Fifth & Virginia Streets on a spur of the Southern Pacific Railroad. It will be about 60% larger than the Oakland Plant which has serviced the West Coast area previously. R. J. Christ is Plant Manager.

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New Metal Washing Machine Announced by Optimus

OPTIMUS EQUIPMENT COMPANY, 251 Church Street, Matawan, N. J., has introduced a continuous type washing machine for handling metal parts on racks, before plating, painting or any similar process. It will handle any type of parts provided they are free-draining, and the sprays have free access to the parts. The output of the machine is high — 60 racks per hour being common.

* * *

THIS machine can be used as a single stage washer, or it can handle a number of successive operations, alkaline, acid, or neutral. With slight alterations, the machine can take care of a series of different operations — washing, rinsing, drying, pickling, cyanide treatment, etc. If an acid solution is used, the machine is furnished built of acid-proof material. In most cases, it is desirable to use it only as a washing and rinsing machine. Its greatest use is for the cleaning of buffing compositions after buffing and before plating.

* * *

THE machine works closed and may be connected to an exhaust blower so that fumes, unpleasant odors or excessive heat is not developed. It can be heated by steam, gas or electricity.

Lindberg Carbon Determinator

DEDICATED to the idea that easier operation produces faster, more accurate carbon determinations, the new **Lindberg Volumetric Type Carbon Determinator** introduces a number of features which achieve that end.

* * *

THE precisely graduated burette mounted in front of a flourescent light for easier reading, makes for an accuracy of one point of carbon . . . or better. It also eliminates eye fatigue. Burette is water jacketed and graduated for 1-gram and ¼-gram samples permitting full range use in analyzing the carbon in iron, steel, heat resisting steel, stainless steel and other materials.

* * *

THE absorption chamber permits complete absorption in two passes — for many alloys, one pass is sufficient. The chamber combines the use of glass tubing and glass beads, achieving quick, thorough gas dispersion.

* * *

ALTHOUGH designed for use with Lindberg Combustion Tube Furnaces, the new Lindberg Carbon Determinator is easily and quickly adapted for use with any high temperature combustion tube furnace. Manufactured by Lindberg Engineering Company, 2444 West Hubbard Street, Chicago 12, Ill., the determinator is sold through laboratory equipment dealers.

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Lubricants in Copper Alloy Shaping

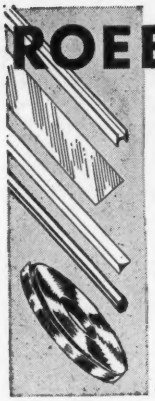
WITH the removal of wartime restrictions on copper-base alloys many industries are again using brasses, bronzes, and the improved copper-base engineering alloys. Hence the timeliness of a discussion on the selection and use of lubricants, used for cupping, stamping and machining such metals appearing in a **Copper Alloy Bulletin** (prepared by the Bridgeport Brass Co.). Here it is pointed out that soap and soap pastes are among the most common materials used for this purpose. Thus, when employed as lubricants for blanking and cupping operations, soaps generally are diluted in ratios of from one part of compound to four of water to as high as one part of soap compound to twenty of water. More dilute lubricants are preferred in drawing and forming operations. Tallow, palm oil, or vegetable oil soaps possess sufficient lubricating qualities and are often used. For some work, as little as one pound of soap compound to ten gallons of water is sufficient. Dilute soap solutions are easily removed by washing with warm water.

* * *

ALTHOUGH wet lubricants are most generally used, dry lubricants like powdered soap also have been employed for drawing wire. In the dry soap process for drawing and forming, 8 to 12 ounces of flake soap are used per gallon of water. The parts are immersed in this solution and dried. The film of dry soap acts as the lubricant and provides the added advantage of conveying, handling, and storing dry cups and shells. Soap-and-water mixtures are sometimes used in machining, drilling or tapping procedures; this depending upon the equipment and the nature of the cut.

* * *

IT is pointed out that, when soap compounds require mixing with water, the use of steam-heated kettles with agitating devices is helpful.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A Review of Recent Wire Patents

(*Continued from page* 541)

More specifically, the invention resides in the wire feed, including a pair of feed rolls, with their drive shaft having a split cone pulley also driven thereby. There is a pulley in alignment with the split cone pulley to drive a reel carrying a belt, tensioned between this pulley and the reel pulleys.

* * *

No. 2,401,101, APPARATUS FOR DETECTING LEAKS, patented May 28, 1946 by Leonard T. Pockman, San Francisco, Calif., assignor to Heintz &!Kaufman, Ltd., South San Francisco, Calif., a corporation of Nevada.

For detecting leaks in a section of wire, there is provided a wall of resilient material, having a wire-receiving perforation. One side of the wall is adapted to be exposed to a gas and the other to a moderately high viscosity oil with the pressure on the gas side exceeding that on the oil side.

* * *

No. 2,401,147, APPARATUS FOR CUTTING METAL, patented May 28, 1946 by Crosby Field, Brooklyn, and Gerald C. Toole, St. Albans, N. Y., assignors to Brillo Manufacturing Company, Inc., Brooklyn, N. Y., a corporation of New York.

Metal wool is shaved from wire by the operation of this apparatus.

* * *

No. 2,401,149, WIRE STRIPPING MACHINE, patented May 28, 1946 by Reuben Gordon, Seattle, Wash., now by judicial change of name, Robert Gordon.

Included are a number of cutting blades, radially slidably mounted on a driven plate and provided with pins engaging cam slots, which latter may have portions thereof cut off by stop plates whereby the wire is progressively stripped of its insulated covering, or coverings of various thicknesses may be removed.

* * *

Fort Wayne Wire Die Offers New Booklet

"WIRE Die Know-How, Plus" is the title of an interesting and colorful booklet just completed and ready for distribution by the **Fort Wayne Wire Die, Inc.**, of Fort Wayne, Indiana. The firm, headed by **Paul Bieberich,** manufactures diamond wire drawing dies, and offers to send the booklet without charge to interested firms and individuals. The book details the history and growth of the Fort Wayne Wire Die, Inc., as well as the development of the industry as a whole in the United States.

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Copper and Copper Alloy Springs

(*Continued from page 533*)

bronze curves cross — an anomalous result on which the authors make no comment.

* * *

TO overcome variations of stiffness with change of temperature a self-compensating spring has recently been introduced in the U.S.A. [41, 42] (Pat. No. 2246158) which is made in two parts — one being the normal choice of material having a negative temperature coefficient of modulus, and the other a 36% nickel-iron alloy having a positive coefficient of about 0.0005. Clearly by appropriate design it is possible to ensure that no change of modulus occurs with temperature; or a change of modulus may be arranged which will compensate for other instrumental changes.

All References will be found at the end of Part I, printed in the April 1946 issue.

Booklet on Corrosion Resistant Steel

OTISCOLOY is one of the most interesting and important of the large and diversified family of the **Jones & Laughlin Steel Corporation** controlled quality steels. Otiscoloy is a high-tensile, low-alloy steel manufactured by J & L to meet trade's need for a readily weldable and easily fabricated, corrosion resistant steel of substantially greater strength than the standard carbon structural steels.

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THE Jones & Laughlin Steel Corporation recently published a very attractive 16-page 2-color illustrated booklet, giving technical information, suggested applications and other useful information of their new weight-saving J & L steel. Copies are available upon request by writing: Publicity Manager, Jones & Laughlin Steel Corporation, Pittsburgh 30, Pa.

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Norton Co., Worcester, Mass.

ACID INHIBITORS—
American Chemical Paint Co., Ambler, Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.

ACID-PROOF CONSTRUCTION—
Ceilcote Co., The, Cleveland, Ohio.
Haveg Corporation, Newark, Del.
Heil Engineering Co., Cleveland, Ohio.
Sauereisen Cements Co., Pittsburgh, Pa.

AIR DRAW FURNACES
Carl-Mayer Corp., Cleveland, Ohio.

ALKALINE CLEANERS—
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Oakite Products, Inc., New York, N. Y.

ANNEALING MACHINES—Open Flame
Syncro Machine Co., Perth Amboy, N. J.

ANNEALING POTS AND BOXES—
National Annealing Box Co., Washington, Penna.
Scudder, E. J., Foundry & Machine Co., Trenton, N. J

ARMORING EQUIPMENT—
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

BAKERS—Rod and Wire
Carl-Mayer Corp., The, Cleveland, Ohio.
Morgan Construction Co., Worcester, Mass.
Moslo Machinery Co., Cleveland, Ohio.
Ross, J. O., Engr. Corp., New York, N. Y.

BELTS—Wire
Wickwire Spencer Steel, New York, N. Y.

BENDERS—
O'Neil-Irwin Mfg. Co,. Minneapolis,. Minn.

BOBBINS—Braider & Wire Weaving
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

BORON CARBIDE
Norton Co., Worcester. Mass.

BRAKES—Pneumatic
Entwistle, Jas. L. Co., Pawtucket, R. I.

BRAKES & SHEARS—
O'Neil-Irwin Mfg. Co., Minneapolis, Minn..

BRICKS—Acid Proof
Keagler Brick Co., Steubenville, Ohio.

CABLE LACQUERING OVENS
Industrial Oven Engr. Co., Cleveland, O.

CABLE—Steel and Copper
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Wickwire Spencer Steel, New York, N. Y

CARRIERS—Braider, High Speed
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.

CASTINGS—Wire Mill
Scudder, E. J. Fdry. & Mach. Co., Trenton. N.J.

CEMENTS—Acid Proof
Sauereisen Cements Co., Pittsburgh, Pa.

CEMENTS—Refractory
Norton Co., Worcester, Mass.

CHEMICALS—Cleaning
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.
Standard Industrial Compounds Co., Chicago, Ill.

CLEANERS—Hand and Metal
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Phila, Pa.
Magnus Chemical Co., Garwood, N. J.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Chicago, Ill.

CLEANING & PICKLING EQUIP.—
Broden Construction Co., Cleveland, Ohio.
Cleveland Tramrail Div., of the Cleveland Crane & Engineering Co., Wickliffe, O.
Haveg Corp., Newark, Del.
Heil Engineering Co., Cleveland, Ohio.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls. O.
Wilson, Lee, Engr. Co.. Cleveland. Ohio.

CLOTH TESTERS—
Scott Testers, Inc., Providence, R. I.

CLOTH—WIRE. All Metals
Roebling's John A. Sons, Co., Trenton, N. J.
Wickwire Spencer Steel, New York, N. Y.

COATING COMPOUNDS—
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Chicago, Ill.

COILERS—Sheets, Strip and Wire
Broden Construction Co., Cleveland, Ohio.
Entwistle, Jas. L. Co., Pawtucket, R. I.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J. Machine Co., Newark, N. J.
Torrington Mfg. Co., Torrington, Conn.

COLD HEADERS—
Waterbury-Farrel Foundry & Machinery Co., Waterbury, Conn.

COMPOUNDS—Coppering
American Chemical Paint Co., Ambler, Pa.

COMPOUNDS—Metal Finishing
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.

COMPOUNDS—Rust Preventing
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Oakite Products, Inc., New York, N. Y.
Shell Oil Co., Inc., New York, N. Y.

COMPOUNDS—Rust Removing
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Phila, Pa.
Oakite Products, Inc., New York, N. Y.
Shell Oil Co., New York, N. Y.
Standard Industrial Compounds Co., Chicago, Ill.

COMPOUNDS—Wire Drawing
Apex Alkali Products Co., Phila., Pa.
Bick, Hans C., Inc., Reading, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H. Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Potter, Neil C., Newark, N. J.
Shell Oil Co., Inc., New York, N. Y.
Standard Industrial Compounds, Co., Chicago, Ill.

COPHOLDERS—Steel
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

CRANES—Wire Mill
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

CUTTING TOOLS—Carbide
Carboloy Co., Inc., Detroit, Mich
Firth-Sterling Steel Co., McKeesport, Pa.
Vascoloy-Ramet Corp., North Chicago. Ill.

CUTTING TOOLS—Wire
Porter, H. K., Inc., Everett, Mass.

DIAMONDS—Industrial
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Michigan Wire Die Co., Detroit, Mich.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside. N. J.

DIAMOND POWDERS—
Michigan Wire Die Co., Detroit, Mich.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Union Wire Die Corp., New York, N. Y.
United Die Co., Newark, N. J.
Wayne Wire Die Co., Hillside, N. J.

DIAMOND TOOLS—
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Wayne Wire Die Co., Hillside, N. J.

DIES—Diamond
Ajax Industrial Supplies, Inc., Fort Wayne, Ind.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Cochaud Wire Die Corp., New York, N. Y.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Michigan Wire Die Co., Detroit, Mich.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Union Wire Die Corp., New York, N. Y.
United Die Co., Newark, N. J.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIES—Lead Extrusion
Wayne Wire Die Co., Hillside, N. J.
Robertson, John, Co., Brooklyn, N. Y.

DIES—Repairs & Re-Cutting
Ajax Industrial Supplies Co., Fort Wayne, Ind.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Carboloy Co., Detroit, Mich.
Cochaud Wire Die Corp., New York, N. Y.
Firth-Sterling Steel Co., McKeesport, Pa.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
Michigan Wire Die Co., Detroit, Mich.
New Eng. Wire Die Co., Worcester, Mass.
New Jersey Carbide Die Co., Jersey City, N.J.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Union Wire Die Corp., New York, N. Y.
United Die Co., Newark, N. J.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Rod and Tube Drawing
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Carboloy Co., Inc., Detroit, Mich.
Firth Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
Michigan Wire Die Works, Detroit, Mich.
New Jersey Carbide Die Co., Jersey City, N.J.
Rusch Wire Die Corp., New York, N. Y.
Tungsten Electric Corp., Union City, N. J.
United Die Co., Newark, N. J.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Tantalum Carbide
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
New Jersey Carbide Die Co., Jersey City, N.J.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
United Die Co., Newark, N. J.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Tungsten Carbide
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
Michigan Wire Die Co., Detroit, Mich.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Tungsten Electric Corp., Union City, N. J.
United Die Co., Newark, N. J.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DRAW BENCHES—
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E J. Fdry. & Mach. Co., Trenton, N. J.
Standard Machinery Co, Providence, R I.
Vaughn Machinery Co., Cuyahoga Falls, O.

DRUMS—Flange Steel
Hubbard Spool Company, Chicago, Ill.
Stevens Metal Products Co., Niles, Ohio.

DRUMS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

DRYING & PRE-HEATING ROOMS—
Carl-Mayer Corp., Cleveland, Ohio.
Industrial Oven Engr. Co., Cleveland, Ohio.

DRYING EQUIPMENT—
Carl-Mayer Corp., The, Cleveland, Ohio.
Ross, J. O., Engineering Corp., New York, N. Y.

ENGINEERS—Consulting Wire Mill
Lewis, Kenneth B., Worcester, Mass
Syer, C. Raymond, Westport, Conn.
Wiel, L. D., New York, N. Y.

EQUIPMENT—Insulation Testing
Davis, R. L., Elec. Co, Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I

EYELETS—Brass or Zinc
Platt Bros., & Co., The, Waterbury, Conn.

FENCES AND FENCING—Wire
Wickwire Spencer Steel, New York, N. Y.

FLUXES—Soldering
American Chemical Paint Co., Ambler, Pa.

FOAM PRODUCING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Parkin, Wm. M. Co., Pittsburgh, Pa.

FRICTION PAY-OFF STANDS—
Industrial Oven Engr. Co., Cleveland, Ohio.

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FURNACES—Annealing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Automatic
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Brazing
Electric Furnace Co., Salem, Ohio.
Firth-Sterling Steel Co., McKeesport, Pa.

FURNACES—Bright Annealing
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Electric
Eisler Engineering Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Galvanizing Equipment
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Hard'ing & Temp'ing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Lead Melting
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Robertson, John, Co., Brooklyn, N. Y.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Non-Oxidizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Normalizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Salth Bath
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corporation, Toledo, O.

FURNACES—Wire, Strip & Sheet
Carl-Mayer Corp., The, Cleveland, Ohio.
Eisler Engineering Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Surface Combustion Corporation, Toledo, O.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

GALVANIZING EQUIPMENT—
Hanson, Van Winkle, Munning Co.
Matawan, N. J.

GALVANIZING FLUXES—
Hanson, Van Winkle, Munning Co.
Matawan, N. J.

GALVANIZING KETTLES—
National Annealing Box Co., Washington, Penna.

GOVERNMENT SURPLUS MATERIALS
War Assets Corporation, New York, N Y.

GRINDERS—Roll
Norton Co., Worcester, Mass.

HOISTS—Electric Travelling
Cleveland Tramrail Div. of Cleveland.
Crane & Engineering Co., Wickliffe, Ohio.

INHIBITORS—Pickling
American Chemical Paint Co., Ambler, Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M. Co., Pittsburgh, Pa.

INSULATING LACQUERING SYSTEMS—Continuous
Industrial Oven Engr. Co., Cleveland, O.

INSULATING MATERIALS—
Crepe-Kraft Co., Newark, N. J
Standard Varnish Wks., Staten Island, N. Y.

KETTLES—Galvanizing, Annealing, Tinning, etc.
National Annealing Box Co., Washington, Penna.

LATHES—Die Reaming
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Morgan Construction Co., Worcester, Mass.
Roos, H. & G., Tool & Mfg. Co., Montclair, N.J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

LININGS—Acid and Alkali Proof
Ceilcote Co., The, Cleveland, Ohio.
Haveg Corp., Newark, Del.
Heil Engineering Co., Cleveland, Ohio.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Chicago, Ill.

LUBRICANTS—Wire Drawing
Apex Alkali Products Co., Phila., Pa.
Bick, Hans C., Inc., Reading, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Potter, Neil C., Newark, N. J.
Procter & Gamble, Cincinnati, Ohio.
Standard Industrial Compounds Co., Chicago, Ill.

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

MACHINERY—Brazing
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Bunching
American Insulating Mach'y Co., Phila, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Cable, Electric
American Insulating Mach'y Co., Phila, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Cable, Rope Closing
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Coil Winding
Entwistle, Jas. L. Co., Pawtucket, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Coilers
Broden Construction Co., Cleveland, Ohio.
Eisler Engineering Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
Morgan Construction Co., Worcester, Mass.
New England Butt Co., Providence, R. I.
Ruesch, H. J. Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Copper Wire Drawing and Rolling
American Insulating Mach'y Co., Phila, Pa.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Covering Wire
American Insulating Mach'y Co., Phila, Pa.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cutting
Broden Construction Co., Cleveland, Ohio.
Eisler Engineering Co., Newark, N. J.
Lewis Machine Co., The, Cleveland, Ohio.
Moslo Machinery Inc., Cleveland, Ohio.
National Mach'y Exch., (Used), New York, N.Y.
Nilson A. H. Machine Co., Bridgeport, Conn.
Porter, H. K. Inc., Everett, Mass.
Shuster, F. B. Mfg., Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Die Making
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Roos, H. & G., Tool & Mfg. Co. Montclair, N.J.
Union Wire Die Corp., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.

MACHINERY—Draw Benches
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Edging
Broden Construction Co., Cleveland, Ohio.
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Enameling
American Insulating Mach'y Co., Phila., Pa.
Industrial Oven Engr. Co., Cleveland, O.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Extruding
Robertson John, Co., Brooklyn, N. Y.
Royle, John, & Sons, Paterson, N. J.

MACHINERY—Fence
Broden Construction Co., Cleveland, Ohio.
Glader, Wm. Machine Works, Chicago, Ill.

MACHINERY—Filament Coil Winding
Eisler Engineering Co., Newark, N. J.

MACHINERY—Flat Wire
Broden Construction Co., Cleveland, Ohio.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Forming
Eisler Engineering Co., Newark, N. J.
National Mach'y Exch. (Used), New York, N. Y.
Nilson A. H. Machine Co., Bridgeport, Conn.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.
Seifert, E. R., Inc., Syracuse, N. Y.
Sleeper & Hartley, Inc, Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Galvanizing
Wilson, Lee, Engr. Co., Cleveland, Ohio.

MACHINERY—Galvanizing Wire
Broden Construction Co., Cleveland, Ohio.
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

MACHINERY—Gang Winders
Entwistle, Jas. L. Co., Pawtucket, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co, Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y Co., Phila, Pa.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lead Encasing Presses, etc.
Robertson, John Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
Robertson, John Co., Brooklyn, N. Y.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Magnet Wire
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Material Handling
Cleveland Tramrail, Div. of the Cleveland.
Crane & Engineering Co., Wickliffe, O.

MACHINERY—Measuring Wire & Cable
Durant Mfg. Co., Milwaukee, Wis.
Entwistle, Jas. L. Co., Pawtucket, R. I.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Broden Construction Co., Cleveland, Ohio.
Glader, Wm. Machine Works, Chicago, Ill.
National Mach'y Exch. (Used), New York, N.Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Panning
American Insulating Mach'y Co., Phila., Pa.
Syncro Machine Co., Perth Amboy, N. J.

WHERE TO BUY, Continued

MACHINERY—Pointing
Broden Construction Co., Cleveland, Ohio.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Mach., Co., Trenton, N.J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machinery Co., Waterbury, Conn.

MACHINERY—Rod Mill
Broden Construction Co., Cleveland, Ohio.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.

MACHINERY—Rolling Mill
Broden Construction Co., Cleveland, Ohio.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Waterbury-Farrel Foundry & Machinery Co., Waterbury, Conn.

MACHINERY—Rubber for Insulating Wire
Royle, John & Sons, Paterson, N. J.

MACHINERY—Rubber Tubing and Straining
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Screw Wire
National Mach'y Exch. (Used), New York, N. Y.
Sleeper & Hartley, Inc, Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y Co., Phila, Pa.
Broden Construction Co., Cleveland, Ohio.
Emory, Robert J., Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
New England Butt Co., Providence, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Mach., Co., Trenton, N.J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I. (Special Designs).
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spooling
American Insulating Mach'y Co., Phila., Pa.
Eisler Engineering Co., Newark, N. J.
Emory, Robert J., Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N .J.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machinery Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

MACHINERY—Spring Making
National Mach'y Exch. (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Broden Construction Co., Cleveland, Ohio.
Lewis Machine Co., The, Cleveland, Ohio.
Moslo Machinery Co., Cleveland, Ohio.
National Mach'y Exch. (Used), New York, N. Y.
Nilson A. H. Machine Co., Bridgeport, Conn.
Ruesch, H. J., Machine Co., Newark, N. J
Shuster, F. B., Mfg. Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Stranding
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Broden Construction Co., Cleveland, Ohio.
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Swaging
National Mach'y Exch. (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N .J.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Taping
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N .J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Testing Equipment—Sparkers
Davis, R. L., Elec. Co., Wallingford, Conn.
Entwistle, Jas. L., Pawtucket, R. I.

MACHINERY—Testing Spring
Standard Machinery Co., Providence, R. I.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y Co., Phila., Pa.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Trolley Wire
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Welding Wire
Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago, Ill.
Moslo Machinery Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Winding
American Insulating Mach'y Co., Phila., Pa.
Eisler Engineering Co., Newark, N. J.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Mill Supply Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wind-up (Constant Tension, Variable Speed)
Industrial Oven Engr. Co., Cleveland, O
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Bending
Eisler Engineering Co., Newark, N. J.
Nilson A. H. Machine Co., Bridgeport, Conn.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.

MACHINERY—Wire Drawing
American Insulating Mach'y Co., Phila, Pa.
Broden Construction Co., Cleveland, Ohio.
Eisler Engineering Co., Newark, N. J.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Mach., Co., Trenton, N.J.
Sleeper & Hartley, Inc, Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Wire Rope
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J .

MACHINERY—Wire Tinning
American Insulating Mach'y Co., Phila, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Wood Screw
National Mach'y Exch. (Used), New York, N. Y.

MATERIAL HANDLING EQUIPMENT
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

MILLS—Tandem Rolling and Fdging
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., Torrington, Conn.

NAILS—Wire
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip
Hudson Wire Co., Ossining, N. Y.

OILS—Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Procter & Gamble, Cincinnati, Ohio.
Shell Oil Co., New York, N. Y.
Standard Industrial Compounds Co., Chicago, Ill.

OVENS—Cable Lacquering
American Insulating Mach'y Co., Phila., Pa.
Industrial Oven Engr. Co., Cleveland, Ohio.

OVENS—Dehydrogenizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Oven Engr. Co., Cleveland, Ohio.

OVENS—Industrial
Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Oven Engr. Co., Cleveland, Ohio.
Ross, J. O., Engr. Corp., New York, N. Y.

OVENS—Welding Rod Coating
Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Oven Engr. Co., Cleveland, Ohio.
Moslo Machinery Co., Cleveland, Ohio.

PAINTS—Heat Resisting
American Chemical Paint Co., Ambler, Pa.

PAINTS—Marine
American Chemical Paint Co., Ambler, Pa.

PAINTS—Structural Steel
American Chemical Paint Co., Ambler, Pa.

PANS—Lead and Spelter
National Annealing Box Co., Washington, Penna.

PANS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Maass.

PAPER—Creped Wrapping
Crepe-Kraft Co., Newark, N. J.

PAPER—For Coil Wrapping and Corrosion Prevention
Crepe-Kraft Co., Newark, N. J.

PAPER TESTERS—
Scott Testers, Inc., Providence, R. I.

PATENT ATTORNEYS—
Lancaster, Allwine and Rommel, Washington, D.C.

PICKLING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Phila., Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.

PICKLING TANK LININGS—
Ceilcote Co., The, Cleveland, Ohio.
Haveg Corp., Newark, Del.
Heil Engineering Co., Cleveland, Ohio.
Sauereisen Cements Co., Pittsburgh, Pa.

PIPES & FITTINGS—Acid Resistant
Ceilcote, Co., The, Cleveland, Ohio.
Haveg Corp., Newark, Del.
Heil Engineering Co., Cleveland, Ohio.

PLASTIC TESTERS—
Scott Testers, Inc., Providence, R. I.

POTS—Lacquer
Industrial Oven Engr. Co., Cleveland, O.

POTS—Lead Melting
National Annealing Box Co, Washington, Pa.
Robertson, John, Co., Brooklyn, N. Y.

POWDER—Wire Drawing
Apex Alkali Products Co,. Phila, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Inc., Homer, N. Y
Potter, Neil C., Newark, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

PRESSES—Hydraulic and Mechanical
Robertson, John, Co., Brooklyn, N. Y.
Standard Machinery Co., Providence, R. I. (Mechanical Only)

PRESSES—Lead
Robertson, John, Co., Brooklyn, N. Y.

PRESSURE VESSELS—
National Annealing Box Co., Washington, Penna.

PULLERS—Wire
Scudder, E. J., Fdry. & Mach., Co., Trenton, N.J.
Sleeper & Hartley, Inc, Worcester, Mass.
Entwistle, Jas. L. Co., Pawtucket, R. I

PUMPS—Hydraulic
Robertson, John, Co., Brooklyn, N. Y.

REEL AND TENSION STAND—
Industrial Oven Engr. Co., Cleveland, O.
Moslo Machinery Co., Cleveland, Ohio.
Sleeper & Hartley, Inc, Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS—Annealing and Stranding
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Moslo Machinery Co., Cleveland, Ohio.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, Ohio.

REELS—Collansible
Entwistle, Jas. L. Co., Pawtucket, R. I.

REELS—Steel
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, Ohio.

REELS AND SPOOLS—Shipping and Shop
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, Ohio.

WHERE TO BUY, Continued

REELS—Takeoff
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Moslo Machinery Co., Cleveland, Ohio.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B., Mfg. Co., New Haven, Conn.
Stevens Metal Products Co., Niles, Ohio.

REELS—Vulcanizing & Impregnating
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, Ohio.

REELS—Wire Drawing
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Moslo Machinery Co., Cleveland, Ohio.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, Ohio.

REFRACTORIES—High Temperature
Norton Company, Worcester, Mass.

ROD BAKERS—
Carl-Mayer Corp., The, Cleveland, Ohio.
Moslo Machinery Co., Cleveland, Ohio.
Ross, J. O., Engineering Corp., New York, N.Y.

RODS—Stainless Steel
Rustless Iron & Steel Div., American Rolling Mill Co., Baltimore, Md.

RODS—Wire—Non-Ferrous
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.

RODS—Wire—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Indiana.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's John A., Sons Co., Trenton, N. J.
Wickwire Spencer Steel, New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

ROLL STRAIGHTENERS—
Moslo Machinery Co., Cleveland, Ohio.

ROPE—Wire
Bethlehem Steel Co., Bethlehem, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Roebling's, John A., Sons Co., Trenton, N. J.
Wickwire Spencer Steel, New York, N. Y.

RUBBER AND RUBBER COMPRESSION TESTERS—
Scott Testers, Inc., Providence, R. I.

RUST PROOF COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Oakite Products, Inc., New York, N. Y.

RUST REMOVING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Heil Engineering Co., Cleveland, Ohio.
Standard Industrial Compounds Co., Chicago, Ill.

SATURATION SYSTEMS
Industrial Oven Engr. Co., Cleveland, Ohio.
Watson Machine Co., Paterson, N. J.

SHEARS—
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.

SHEET—Steel
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, O.

SOAPS—Industrial and Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Bick, Hans C., Inc., Reading, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H. Co., Inc., Homer, N. Y.
Potter, Neil C., Newark, N. J.
Procter & Gamble, Cincinnati, Ohio.
Shell Oil Co., Inc., New York, N. Y.
Standard Industrial Compounds Co., Chicago, Ill.

SOLVENT RESIN SYSTEMS—Experimental
Industrial Oven Engr. Co., Cleveland, Ohio.

SPOOLS—Annealing and Wire Drawing
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, Ohio.

SPOOLS—Shipping and Shop
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, Ohio.

SPOOLS—Steel
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, Ohio.

SPRINGS—Steel
Wickwire Spencer Steel, New York, N. Y.

SPRINGS—Tools for Forming
State Machine Tool Co., Hartford, Conn.

STAMPINGS—Steel
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRAND—Steel and Copper
Wickwire Spencer Steel, New York, N. Y.

STRIP—Brass and Non-Ferrous
Hudson Wire Co., Ossining, N. Y.

STRIP—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Firth-Sterling Steel Co., McKeesport, Pa.
Jones & Laughlin Steel Corp., Pittsburgh, Pa
Roebling's, John A., Sons Co., Trenton, N. J.
Wickwire Spencer Steel, New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

SWIFTS—Take-off
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Watson Machine Co., Paterson, N. J.

TANK LININGS—Brick
Ceilcote Co., The, Cleveland, Ohio.
Keagler Brick Co., Steubenville, Ohio.

TANK—Compound
Haveg Corp., Newark, Del.
Watson Machine Co., Paterson, N. J.

TANKS—Pickling
Ceilcote Co., The, Cleveland, Ohio.
Haveg Corp., Newark, Del.
Heil Engineering Co., Cleveland, Ohio.
Sauereisen Cements Co., Pittsburgh, Pa.

TANKS—Steel
Mossberg Pressed Steel Corp., Attleboro, Mass.
National Annealing Box Co., Washington, Penna.

TESTING INSTRUMENTS—
Davis, R. L., Elec. Co., Wallingford, Conn.

TOOLS—Spring Forming
State Machine Tool Co., Hartford, Conn

TOOLS—Wire Cutting
Porter H. K., Inc., Everett, Mass.

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of the Cleveland. & Engineering Co., Wickliffe. O.

TRAVERSES—For Reels
Entwistle, James L. Co., Pawtucket, R. I.
Hubbard Spool Company, Chicago, Ill.
Stevens Metal Products Co., Niles, Ohio.

TRAVERSE MECHANISMS—
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

TREADS—Safety
Norton Co, Worcester, Mass.

TUBE BENDERS AND FORMERS—
Ruesch, H. J. Machine Co., Newark, N. J.

TURKS HEADS—Friction and Power
Standard Machinery Co., Providence, R. I.

VALVES AND FITTINGS—Acid Resistant
Haveg Corp., Newark, Del.

VARNISHES—For Insulation
Standard Varnish Wks., Staten Island, N. Y.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y Co., Phila., Pa
Mossberg Pressed Steel Corp., Attleboro, Mass.

WELDERS—Spot and Butt
Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago, Ill.
Moslo Machinery Co., Cleveland, Ohio.

WIND-UP AND UNWIND SYSTEMS—Continuous
American Insulating Mach'y Co., Phila, Pa.
Davis, R. L., Electric Co., Wallingford, Conn.
Entwistle, James L. Co., Pawtucket, R. I.
Industrial Oven Engr. Co., Cleveland, O.
Watson Machine Co., Paterson, N. J.

WIRE—Aluminum
Aluminum Co. of America, Pittsburgh, Pa.

WIRE—Cast
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Cold Heading
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's John A., Sons Co., Trenton, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Electric
Hudson Wire Co., Ossining, N. Y.

WIRE—Enameled for Coils
North American Philips Corp., Dobbs Ferry, N.Y.
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Manufacturers
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Firth Sterling Steel Co., McKeesport, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's, John A., Sons Co., Trenton, N. J.
Rustless Iron & Steel Div., American Rolling Mill Co., Baltimore, Md.
Wickwire Spencer Steel, New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Music
Johnson Steel & Wire Co., Inc., Worcester, Mass.

WIRE—Nickel Silver and Phosphor Bronze
Hudson Wire Co., Ossining, N. Y.

WIRE—Non-Ferrous to Specification for Special Purposes
Hudson Wire Co., Ossining, N. Y.
North American Philips Corp., Dobbs Ferry, N.Y.
Winsted Div. of Hudson Wire Co., Winsted Conn.

WIRE—Spring
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Indiana.
Firth-Sterling Steel Co., McKeesport, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Rustless Iron & Steel Div., American Rolling Mill Co., Baltimore, Md.
Wickwire Spencer Steel, New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Stainless Steel
Firth-Sterling Steel Co., McKeesport, Pa.
Rustless Iron & Steel Div., American Rolling Mill Co., Baltimore, Md.

WIRE—Steel—Also Coppered Steel—Also Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Firth-Sterling Steel Co., McKeesport, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Wickwire Spencer Steel, New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O

WIRE TESTERS—
Scott Testers, Inc., Providence, R. I.

WIRE—Zinc
Platt Bros. & Co., The, Waterbury, Conn.

WIRE, WEAVING—Non-Ferrous
Hudson Wire Co., Ossining, N. Y.

WIRE WINDER—
Standard Mill Supply Co., Providence, R. I.

WRAPPING PAPER—Creped
Crepe-Kraft Co., Newark, N. J.

YARN TESTERS—
Scott Testers, Inc., Providence, R. I.

The WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON 3, NEW JERSEY, U. S. A.

Wire & Wire Products

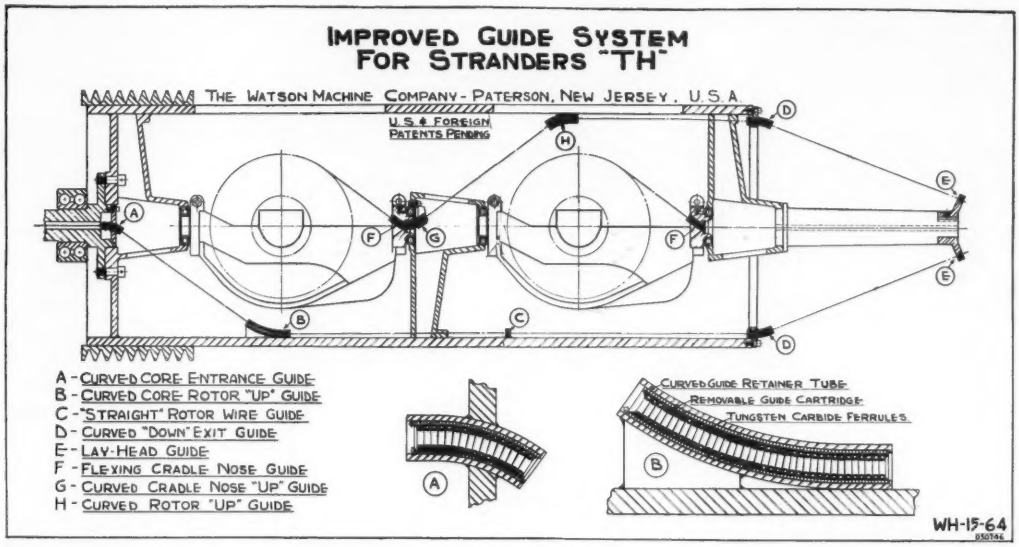
July, 1946

ELECTRICAL WIRE AND CABLE AND WIRE ROPE MACHINERY

NEW and IMPROVED GUIDES

United States and Foreign Patents Pending

ELIMINATION OF SHARP CURVES AT WIRE PATH CHANGE POINTS, **INDEFINITE WIRE GUIDE LIFE** AND **EXTREMELY SIMPLE CONSTRUCTION** ARE THE **OUTSTANDING ADVANTAGES** OFFERED BY THIS NEW IMPROVED GUIDE SYSTEM. It has already been well received by all present users and is **now "STANDARD" on all of our bare wire high-speed Stranders and Closers.**


IMPROVED GUIDE SYSTEM
FOR STRANDERS "TH"
THE WATSON MACHINE COMPANY - PATERSON, NEW JERSEY, U.S.A.
U.S. & FOREIGN PATENTS PENDING
A - CURVED CORE ENTRANCE GUIDE
B - CURVED CORE ROTOR "UP" GUIDE
C - "STRAIGHT" ROTOR WIRE GUIDE
D - CURVED "DOWN" EXIT GUIDE
E - LAY-HEAD GUIDE
F - FLEXING CRADLE NOSE GUIDE
G - CURVED CRADLE NOSE "UP" GUIDE
H - CURVED ROTOR "UP" GUIDE
CURVED GUIDE RETAINER TUBE
REMOVABLE GUIDE CARTRIDGE
TUNGSTEN CARBIDE FERRULES
WH-15-64

These guides have been thoroughly **tested in actual service** on many machines **for over one year without one single Guide Cartridge replacement** and prospective users will be interested in the following noteworthy points:

1. — **Objectionable guide clogging does not occur** after long periods of operation under severe conditions.

2. — The **long guide curve radii reduce cold working** of the product to a minimum and **eliminate "slack-wire curling"**, formerly caused by small guide sheaves or single guide ferrules.

3. — The **smooth-polished Tungsten Carbide Guide Elements** and the **long guide curve radii** greatly **reduce the power effort** required to pull the wire or strand through the guides.

4. — Any **possibility of wires catching** in badly worn sheaves or in sheave mounting brackets, has been **entirely eliminated.**

5. — **"Threading" and "Fishing" is greatly simplified,** and the time formerly required for such operations, considerably reduced.

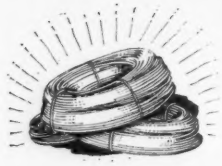
6. — The "flexing" Tungsten Carbide **Guide Cartridge** in its rigid curved tubular retainer chamber can be **quickly replaced** by the machine operator. Such replacements do not require the services of a maintenance mechanic.

* * *

SUMMED UP:—THE INTRODUCTION OF THIS NEW AND IMPROVED GUIDE SYSTEM RESULTS IN A **REDUCTION OF "IDLE" MACHINE PERIODS, LOWERED MAINTENANCE AND REPLACEMENT EXPENSES** AND IN **A BETTER STRANDED PRODUCT.**

EF Furnaces

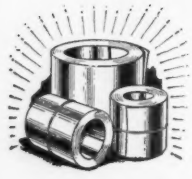
For Bright Annealing Wire, Strip, Tubing, etc.



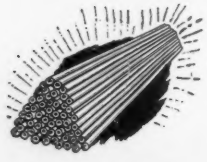
The Above Combination Gas - Electric Furnace

With Heavy V-type Cast Grid Heating Elements
and EF Gas-Fired Recuperative Type Radiant Tubes

Bright Anneals 2500 lbs of Copper Wire Per Hour



Bright, uniformly annealed copper wire — at the rate of 1¼ tons per hour — is discharged continuously from the above combination gas-electric, controlled atmosphere furnace. This furnace handles rod in coils up to 36" in diameter as well as wire on large reels. The material is carried through the furnace on bulkhead type trays which provide an effective seal for the protective atmosphere used in the equipment. These trays eliminate the use of doors, lock chambers, or other sealing devices at either the charging or discharging ends of the furnace.



The heating chamber is divided into two separately and automatically controlled zones. the first or charging zone is heated by EF gas-fired recuperative type radiant tubes. The second os soaking zone is heated by heavy V-type cast alloy heating elements. The heating elements in each zone are located above and below the charge and extend the entire width of the chambers, insuring absolute temperature uniformity throughout the charge.

The protective atmosphere is produced in an EF generator located beside the furnace.

Other outstanding EF production furnace installation include furnace for bright annealing, both ferrous and non-ferrous strip, wire, tubing and other products . . . furnaces for the production heat treatment of bolts, springs, castings, stampings and forgings; as well as furnaces for aluminum, copper and brass brazing; billet heating, scale-free hardening and other processes.

Submit your furnace problems to EF engineers . . . . we specialize on building production furnaces.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

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